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THE TOWERS OF THE BROOKLYN BRIDGE.

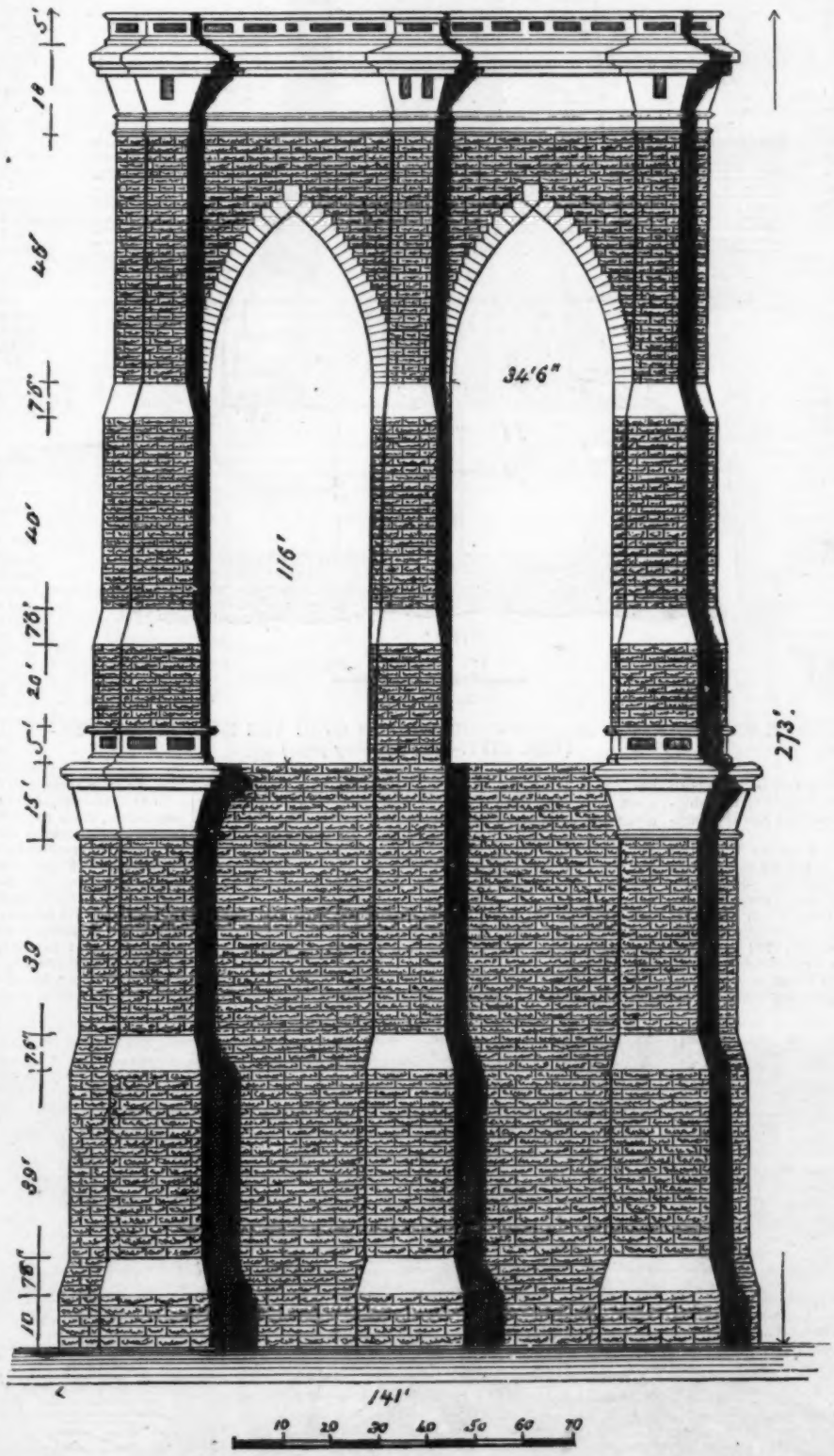
WHOEVER has occasion to travel back and forth on the boats of the Fulton Ferry must frequently be amused by the somewhat crude guesses he hears made as to the height, breadth, and total weight of the New-York and Brooklyn Bridge towers. Nor is it at all surprising, for their proportions are such as are well calculated to deceive one not thoroughly familiar with the measurement of vertical distances by the eye. As is well known, both towers rest on solid timber foundations at a depth of some seventy-eight feet below high-water; that of the Brooklyn tower having a thickness of fifteen, and that under the New-York tower a thickness of twenty feet, and covering an area of 17,500 square feet. At this point this latter tower has a total breadth along the river of 157 ft., and a thickness of 77 ft., while at the water-line these dimensions are respectively 141 and 59 ft. From the high-water line to the flooring the vertical distance is 119 ft., and from the flooring to the roof 149 ft., thus making a total height of 268 ft., measuring from high-water to the roof, without balustrade; or, measuring from the base of the foundation, which is 31 ft. below the base of the masonry, the total height is, to the *top* of the balustrade, 354 ft.

The tower, a front elevation of which is given in Fig. 1, is not, as appearances would lead the observer to suppose, a solid mass of masonry. It consists, in fact, of three main shafts, united below the flooring by connecting walls, the latter thus enclosing two square hollow places, made for the sole purpose of saving masonry. These hollows, or "wells," as they are technically termed, have each a length in the direction of the river of 27 ft. 6 in. by a width of 15 ft. 3 in., the measurements being taken at the top of the timber foundation. From here, by a series of offsets, these rise to the water-line, where they are 33 ft. 6 in. by 20 ft., while at the flooring they have become so much enlarged that the walls forming the river and land sides of the wells, which at the foundation are 24 ft. thick, have dwindled down to 9 ft. A transverse section of the tower from floor to caisson (taken through one of the wells) is shown in Fig. 2. Above the flooring the three shafts, which are solid masonry throughout, rise singly for a height of 80 ft., and are then united by two Gothic archways of 36 ft. rise, 34 ft. span, and 45 ft. radius, covering the roadways.

The masonry consists of granite from the island quarries in Penobscot Bay, on the coast of Maine, and limestone from Kingston, Lake Champlain, and Canajoharie. The first seven courses of masonry on the Brooklyn tower are composed of rough blocks all bedded to a uniform rise, all rectangular in shape, with vertical faces trimmed down so as not to exceed joints four inches wide when laid in the wall. Kingston lime-stone was alone used for these courses, but as the water-line was approached granite was substituted as a facing-stone, limestone being used as a backing. The dimensions of the stones varied from 30 to 100 sq. ft., and the weight from seven to ten tons. The total amount of masonry used in the New-York tower will be, from the timber foundation to the summit, 44,000 cubic yards, giving a weight of 93,000 tons on top of the timber, including in this weight the superstructure. These quantities, however, do not include the weight of the timber and concrete (of which there are 3300 cubic yards) foundation below the masonry. Including the latter we have a pressure on the base of the entire structure of *six and a half* tons per square foot; on top of the timber foundation *ten tons*; on the masonry at the water-line *thirteen and a half tons*, while that at the *base* of the *central shaft* at the floor-line reaches the enormous amount of *twenty-six tons* per square foot of surface.

From the towers thus constructed the superstructure is suspended from four main cables, each 16 in. in diameter, by means of steel-wire ropes. This superstructure, or the bridge proper, is divided into three spans—one long span reaching across the river from tower to tower, a distance of 1595 ft. 6 in., measuring from centre to centre of towers, and two land spans of 930 ft. each, measuring from the centres of the towers to the *water* faces of the anchorages. The remaining portions of the bridge, which reach from the anchorages to the termini, and are called the *approaches*, have a length, that on the New-York side of 1562 ft. 6 in., and that on the Brooklyn side a length of 971 ft. exactly, measuring in each case from the water-face of the anchorage to the end of the bridge. The terminus in Brooklyn is on Sands street; that in New-York on Chatham street, quite near the City Hall. The flooring of the bridge where it passes the towers has a height of 119 ft. above mean tide-water, and from here it rises in a steady grade to a point midway between the two towers, where the height above low-water is 140 ft., and above mean tide 135 ft. This height has been based upon a careful classification of the vessels sailing in and out of the harbor, and is sufficient to afford free passage to all steamers, and all barks, sloops, schooners, and brigs under one thousand tons. Those above this measurement will have to lower their topgallant masts in passing, but as these comprise less than one-tenth of the number of vessels (or about one in two hundred) likely to pass under the bridge, and as the growing application of steam for carrying purposes is constantly lessening their number, the inconvenience is at most but trivial.

The entire length of the bridge is thus from end to end 5989 ft., or very nearly 1¼ miles. Of this, 3455 ft. 6 in. are taken up by the suspended portion, and 2533 ft. 6 in. by the approaches, which latter are not to be suspended, but supported by iron columns and small masonry piers. They have a grade of 3.25 ft. per hundred. Ground was broken for the Brooklyn tower in the summer of 1870, and for the New-York tower two years later. The former is now entirely completed with the exception of the balustrade, which can not be added till the cables are in place. The New-York tower, it is expected, will be finished early this summer.



THE BROOKLYN TOWER OF THE GREAT SUSPENSION-BRIDGE OVER THE EAST RIVER, NEW-YORK CITY.

PROPOSED NEW DRAW-BRIDGE FOR THE THAMES RIVER, LONDON.

[A paper recently read before the Society of Arts, London.]

By FREDERIC BARNETT.

THE origin of bridges and the order in which they have been introduced, I think, may be divided into five series.

Firstly, the very earliest were trunks of trees thrown across narrow channels; secondly, suspension-bridges; thirdly, bridges supported on arches; fourthly, tubular bridges; and fifthly, girder and trellis bridges.

The first of the series was the most simple, spanning gorges, narrow channels, and brooks; trunks of trees, at first single, later two or more, and as intelligence advanced on the subject, rude floors of rough-hewn wood, placed transversely, were added. Of these primitive bridges we may assume the use in the most remote antiquity. Doubtless the first idea was derived from accidents, a tree felled by storm or lightning.

Of suspension-bridges we have authentic accounts of extreme antiquity. They are known to have been in use in Japan, Thibet, and China; while these bridges are literally immemorial among the natives of South America. However, the earliest discovered in Asia were stated to be vastly superior, these being actually furnished with good substantial roads and footways, suspended by metal chains, solidly fixed on the opposite sides of chasms and river-shores. The Chinese called them Thie Khiao (iron bridges), also Thie so Khiao (iron chain bridges).

According to Pauthier, one of the most ancient known was constructed between 58 and 76 of the Christian era, during the reign of the Emperor Ming-ti of the Han dynasty.

Though in Europe, during the 15th and 16th centuries, several suspension-bridges were projected, the earliest of which we have a positive knowledge is comparatively modern, being established in the year 1741. It was of very modest

proportion; in fact, nothing more than a foot-bridge, 65 feet long by about two feet wide, spanning a narrow part of the Tees at Sunderland.

In 1796, in the United States, a similar bridge was constructed, of much bolder proportions, accommodating carriages as well as foot-passengers. Amongst the most remarkable suspension-bridges now existing in Europe we may quote the one spanning the Menai Straits, uniting the Isle of Anglesey and Carnarvon; it is 550 feet long and 100 feet above the level of the sea; it was constructed by our English engineer Telford.

Next in importance is that in France at the Roche Bernard, over the river Vilaine, about 660 feet between the points of suspension, and 100 feet above the highest tide of the river. The author of this bridge was Mons. P. Leblanc, engineer of the Ponts et Chaussées, Paris. There is one still more remarkable at Fribourg, in Switzerland, with a single span, nearly 900 feet, constructed by the engineer Mons. Chaley. There is another yet more important at Cabzac, over the river Dordogne; it exceeds 2000 feet in length, but is sustained by five piers nearly equidistant.

Although engineers have generally opposed suspension-bridges for railways, there is one nearly 800 feet long crossing the Niagara just above the Falls. This bridge has two roads, or floors, the upper serving for the railway; the lower, vehicles and foot-passengers. This unites the Canadian and United States railways.

Of fixed bridges, composed of stone piers and timber roads, Diodorus Siculus makes mention of the first, and this is well authenticated as being built by Semiramis over the Euphrates.

But for entirely arched stone bridges we are indebted to the Romans. It is true some ancient historians speak of Egyptian and Greek entirely stone bridges, which would suggest the idea that, if entirely stone, they were constructed with arches. But as it is generally accepted that the arch was unknown to the Greeks, judging by the monuments they have bequeathed us, I think we may assume also that bridges, which they constructed of stone, were not known either to them or the Egyptians. There is abundant proof that the Greeks visited Egypt. It is a traditional fact, commonly known, that Cadmus, of Thebes, returned thence, bringing with him the Greek alphabet, which he copied from the Hebrew characters. You remember that Cadmus is spoken of as the father of letters. Hence we may be assured that had the arch been known in Egypt, and been employed in their buildings, it would have been reproduced by such people as the Greeks in their incomparable architecture. It is however, certain that the Romans have transmitted to us such monuments, and judging from their remains, we have proof positive of the high standard of the ability of their architects, and their perfect mastery of the arch.

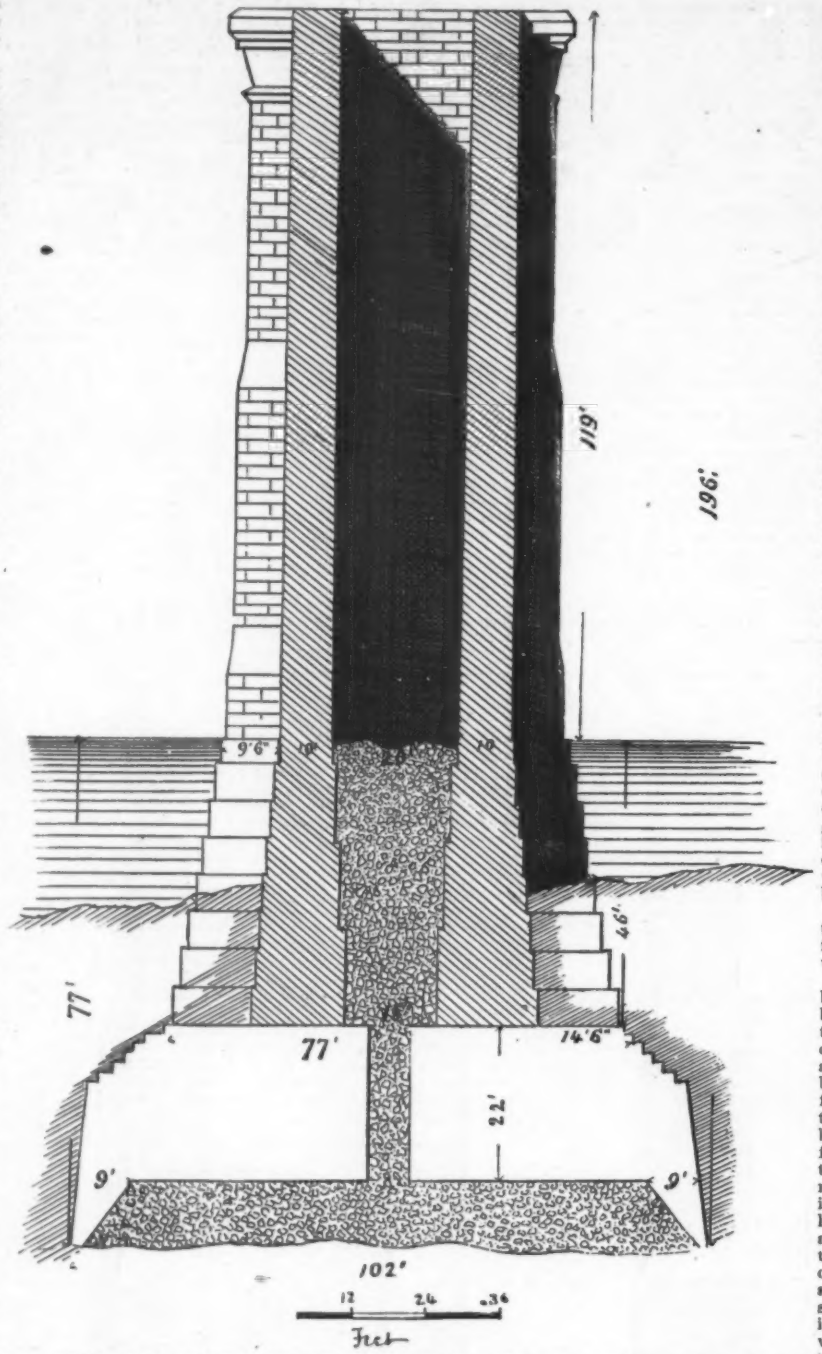
In the valley of Narni, Italy, there still exists a Roman bridge composed of a single arch, nearly 100 feet wide, the keystone of which is nearly 150 feet above the river. For ages architects of all countries followed slavishly the Roman models, adopting alike their perfections and their faults. In the bridges where the Romans had several arches, those nearest the shore were very small; while the centre one was both larger and much higher to facilitate the passage of the shipping of that period. This resulted in an abrupt rise approaching the middle.

Amongst the most remarkable bridges left us from the Middle Ages is that of the Saint Esprit on the Rhone; it was constructed between 1265 and 1309. From that period little or no improvement occurred in bridge architecture till the 16th century, and even then there was none worth recording till the construction of the Neuilly bridge crossing the Seine. This bridge was built by M. Perronet between 1768 and 1773. It narrowly escaped destruction in the Franco-German war, as I saw it mined to be blown up in the event of the Prussians approaching Paris in 1870. It, however, escaped, and looks as fresh as when first built. It is true, old Westminster Bridge was built between 1734 and 1750 by Labeleye, a few years before, but in architecture and material it was very inferior, surviving little more than a century, and even during a great portion of that period it was under repair.

This might, to a certain extent, be attributed to the inexperience of employing Portland stone, a material too perishable to withstand the action of the river. Old Blackfriars was building from 1760 to 1709, and lasted also only a century, having been several times repaired at great expense. It was built by the engineer Milne, and, being also of Portland, met the same fate as that of Westminster, from the same reason.

The magnificent Waterloo Bridge was built of Cornish granite in six years by the great master of the art, Mr. John Rennie, and so scientific is the construction that the New-Zealander 1000 years hence may find it perfect. Mr. John Rennie also built Southwark Bridge between 1814 and 1819, and then finished the plans for London Bridge. The consideration of the overcrowding, and consequent congestion, of this bridge at the present time forms the motive and substance of this paper.

It appears that in very remote periods, even before rafts were used for ferries, in various parts of the Thames there were irregular heaps of stones over which trunks of trees were literally thrown, and so extended as to form foot-bridges of a primitive nature crossing the river, and this was especially the case near the site of old London Bridge. Yet as early as 1008 there appears to have been a bridge, for the Iceland historian Snorro Sturleson gives an account of its destruction by King Anlaf of Norway while assisting King Ethelred against the Danes. This, doubtless, was but a feeble structure of wood, as Anlaf is said to have pulled it down with his ship's cables. It must, however, have been soon rebuilt, as there was a bridge when Canute invaded this country in 1016.



THE BROOKLYN TOWER.—SUSPENSION-BRIDGE OVER THE EAST RIVER, NEW-YORK CITY.—(*See preceding page.*)

London Bridge is also mentioned in a charter of the Conqueror which he granted to the monks of Westminster Abbey in the year 1067.

Several historians speak of the almost complete destruction of this bridge on the 16th November, 1091, by a furious south-east wind, which at the same time threw down 600 houses and several churches in the city. After which it was again rebuilt.

By a charter of the 22d of Henry I., 1122, a grant was made to the monks of Bermondsey of five shillings a year out of the lands pertaining to London Bridge. This small beginning of their endowments of landed property formed the nucleus of what are known as the Bridge-house estates, subsequently so well nursed by the intelligence, zeal, and thrift of the trustees in all succeeding generations, till they have now attained an annual revenue exceeding £50,000.

Stowe informs us that the bridge was entirely rebuilt in 1163 by one Peter of Colechurch, who lived at the south end of Coneyhoop lane (now Grocers' alley), on the north side of the Poultry, where stood a chapel distinguished as that in which Thomas à Becket was baptized. That bridge was wholly rebuilt, like its predecessors, of wood.

The bridge was again wholly rebuilt between 1176 and 1209 (33 years, being precisely the same period as was occupied by Sir Christopher Wren in building St. Paul's). This time Peter of Colechurch built the bridge of stone, choosing its site rather more westward. Its architect died in 1205, so that, like his great successor, Mr. John Rennie, he had not the great happiness of seeing his bridge finished. Peter, however, was buried in the chapel of Saint Thomas à Becket, which was erected on the central pier of the bridge.

The old bridge consisted of 20 arches; the roadway was 926 feet long; it was 60 feet in height from the river, and 40 feet wide.

In 1350 there were so many houses built on the new bridge on each side that, but for a few openings, it formed a continuous street, leaving a passage of little over 12 feet for traffic. At the eleventh arch from Southwark there was a drawbridge, serving the double purpose of defence and passage for ships on their way to Queenhithe and other wharves above bridge. The houses on the bridge were, fortunately, frequently burnt down, for the windows at that period were not made to open, and their limited space and interior abominations, antagonistic to health, rendered them hotbeds of fever and disease; and, curiously enough, though situated so as to have abundance of fresh air, at least exteriorwise, still at that date the plague, which so constantly visited London, frequently began its ravages on the bridge. This bridge withstood six centuries the attacks of time and tide, and was only removed in 1832. But for nearly 100 years previous it gave evidence of senile decay, and for the greater part of that time, like our poor Temple Bar, it was sustained on crutches.

In 1824 the present magnificent structure of London Bridge was begun, from the designs of Mr. John Rennie, and was carried to a successful completion by his son, Sir John Rennie, for which he received the honor of knighthood from King William the Fourth, who opened the bridge, assisted by Queen Adelaide. When designed by Mr. John Rennie, the proportions of the bridge were ample, with a roadway of 35 feet wide and its footways of 9 feet. But since then the immensely increased population and commerce of London, chiefly converging on this point, demands increased accommodation, and it is a fact agreed by all, that it is now totally inadequate. However it may be effected, it is, I believe, unanimously agreed that in some manner this state of congestion must be relieved, and that the relief can not with safety be longer delayed. The vehicles passing during the busy time of the day average 1700 per hour. The average number of vehicles that pass daily over the bridge is 20,000, and over 100,000 foot passengers, nearly the whole of which cross between 7 A.M. and 7 P.M.

Four projects to effect relief are proposed.

The first is the steam-ferry now in progress of execution. Secondly, a high level bridge with lifts. Thirdly, a new tunnel under the Thames. I now come to the fourth project—my own—a low level bridge to be built in any part of the Thames, permitting a passage to the largest ships, with masts 100 feet high, without interrupting for one minute the vehicular and general traffic. A bridge that may be built in any part of the Thames with easier gradients than any bridge over the river, but allowing through any part a clear passage for barges, steam-

PROPOSED NEW DRAWBRIDGE FOR THE THAMES, AT LONDON.

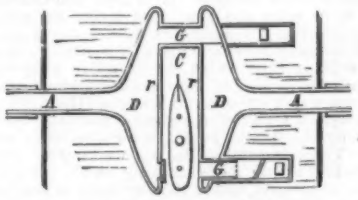
ers, and other craft, yet with exceptional provision and capacity to allow large ships with the highest masts to pass through up to London Bridge, without stopping for one second the vehicular and passenger traffic. My patent bridge, as is seen in the drawing, has but one approach from each shore. When these approaches have extended into the river about one third its width, the roadway splits into two roads, each the same width as the approaches, by easy inclined angles outwardly extending till they meet midway, thus forming a sort of angular oval or loop in the largest diameter. I have on each side two openings, practically covered and united by platforms, turning on their centres, each opening or closing by one operation. These openings permit the entrance on the port side of the largest ships that come up the Thames; there is also a sufficient width allowed for the length of the ships within the loop. From the central piers on which the turntables work there is extended a platform uniting the two extremes, so that this platform lies with the axis of the river, dividing the loop into halves, furnishing the means of mooring the ship a few minutes alongside by mooring-blocks. There are two other platforms running parallel to the chief platform, which keep the ships straight on their road. The vessels return on the opposite, still going port; thus all risk of collision is avoided. The platform will have narrow lighters, rising and falling with the tide, thus protecting both piers and vessels from injury. As soon as a vessel is about to enter the loop, the roadway on the side by which it is to enter is closed, and the vehicular and general traffic, by closing the gates (when the roads divide), is diverted to the opposite side; then immediately the turn-table bridge is opened, and the vessel enters the loop, so that when it is fairly in, the bridge is closed behind it, and, as before described, the traffic is diverted on the road behind the ship, and the opposite turn-table is opened, suffering the ship to pass out on its way. By these means the traffic will suffer neither delay nor inconvenience; the vehicles and general traffic will pass imperceptibly from one side of the loop to the other. Neither frost nor fog will prevent the traffic across the river, which must inevitably occur with the ferries.

Should my patent bridge be adopted, I should propose that it be either a girder or trellis bridge, with three granite tiers on each side, on which the movable roads should work.

Either girder or trellis bridges possess great advantages; firstly, by occupying so small a part of the stream by the columns that carry the roadway; secondly, by their costing such an inferior outlay; and lastly, by their rapidity of construction.

I have little doubt such a bridge could be opened for traffic in less than two years from its commencement.

The historical researches of the author as to ancient and modern bridges are quite interesting, but not sufficiently thorough in respect to the originality of the particular plan that he presents in connection with his name as inventor and patentee. Had he searched the records of the AMERICAN Patent Office, or the pages of the SCIENTIFIC AMERICAN, which are on file in the library of the British Patent Office, he would doubtless have observed that the plan of double draws is an American invention of several years' standing. We give beneath, as one example, a diagram from the patent granted in this country, April 7th, 1868, to Thomas S. Speakman, of Camden, New Jersey.



G G are two draw-bridges, one of which is always open to admit vessels into the draw, while the other is closed to permit the constant passage of traffic, which moves from the roadways A along the widened parts D, according to the respective positions of the draw-bridges.

ON GAS-BURNERS.

By J. PATTINSON, President of the Newcastle Chemical Society.

How best to burn coal-gas so as to obtain the greatest amount of light it is capable of producing, is a subject which is perhaps as yet but imperfectly understood, even by those who know most about it. Great improvements have, however, been made in recent years in the construction of gas-burners, resulting from the researches of Frankland, Bowditch, Sugg, Silber, the London Gas Referees, and others; but from many causes, chiefly, perhaps, for want of information on the subject among the general public, these improved burners have come but very slowly into use. The gas-fitters, to whom the choice of burners is usually left, often know as little about the subject as any one, and thus a wretchedly bad kind of burner is in many cases used which burns the gas so as to destroy a great portion of its light-giving power. In the present paper no attempt is made to describe even a tithe of the multiplicity of burners which have been invented. The object is simply to describe the results of an examination I have recently made of a number of burners taken off fittings in various parts of Newcastle, and to show how unfit these burners are to develop the light-producing properties of gas as compared with good burners, which may be had quite as easily as the bad ones.

Gas-burners may be divided into two great classes: first, Argands, such as give a ring of light and require glass chimneys; second, flat-flame burners, which may be subdivided into what are known as "batwings" and "fishtails," so called from the shape of the flames they produce.

In the experiments I have made, the gas used was of the same quality throughout the whole of the tests. It gave a light equal to 14.1 standard sperm candles when burnt at the rate of 5 cubic feet per hour in the standard Argand burner, known as the Sugg-Lotheby burner. Before about seven or eight years ago this was the best burner known, and as it was in use at the time when the Newcastle and Gateshead Gas Company obtained their Act of Parliament, it is still retained as the standard by which the gas is tested. It is but fair to state here that the quality of the gas was unusually low when the experiments were made, the gas usually being equal to about fifteen standard candles. It may be explained for the benefit of the uninitiated that the standard sperm candle with which the gas is compared is one defined in the Act of Parliament as a "sperm candle of six to the pound, burning at the rate of 120 grains per hour."

I will first of all give the results of the testing of Argand burners. The Argand burner when properly constructed is the one best adapted for obtaining the greatest amount of light from common coal-gas. The air-supply, upon which so much depends, is most perfectly under control in such burners. Argand burners are certainly more expensive in their first cost, and perhaps are more troublesome to keep in order than flat-flame burners, owing to the occasional breakage of chimneys and other causes, but it will be seen that the amount of light they can produce in comparison with the latter is very great, and would soon compensate for their extra cost and the extra trouble of keeping in order, especially in private houses. They require the gas to be supplied to them at a uniform pressure, otherwise they are liable to smoke when the pressure is increased and more gas passes through than they can burn. They should, therefore, always be used with regulators for regulating the pressure of the gas. These may be conveniently placed near the supply-meter.

In each of the following tables the first column shows the actual amount of gas consumed per hour in cubic feet during the experiments; the second gives the illuminating power of the gas consumed expressed in standard sperm candles; the third gives the illuminating power calculated per five cubic feet of gas:

ARGAND BURNERS.

Kind of burner.	Cubic feet of gas used per hour.	Illuminating power in candles.	Illuminating power per 5 cubic feet of gas per hour.
Sugg-Letheby Standard	5.0	14.10	14.10
Sugg's "London Argand"	5.0	15.90	15.90
Sugg's "Improved London Argand"	4.5	16.08	17.86
Silber's Argand	5.0	17.80	17.80
Common Argand	5.0	11.20	11.20
"	7.0	17.80	12.70

The common Argand here mentioned was one similar to a great number used in shop-windows in Newcastle. It will be seen that with the Sugg's Improved London Argand and Silber's Argand as much light is produced when burning five feet of gas as is produced when burning seven feet of gas in the common Argand, thus showing a saving of 40 per cent over the last-named burner.

Flat-flame burners do not consume the gas so as to give as much light from a given quantity of gas as Argands. This is perhaps chiefly owing to the circumstance that it is necessary to make the gas issue from the burner under a certain amount of pressure, in order to produce the required shape of flame, and this pressure causes a portion of the gas to mix with too much air, so that it becomes over-burnt, as in the Bunsen burner. The best flat-flame burners are those in which this pressure is reduced to the minimum amount found necessary, and such burners generally have some contrivance for checking the pressure of gas supplied at the mains. But although flat-flame burners are not so economical as Argands in their consumption of gas, yet they possess other advantages which probably will always cause them to be extensively used. The first cost of the burner is very trifling, no chimneys are required, they are not so liable to smoke under varying pressures of gas as Argands, and they are easily lighted and attended to.

It is in this class of burner that the most extraordinary differences in quality for burning gas so as to produce light have been found. The following table shows the results of my tests of various new batwing and fishtail burners which can be had in Newcastle. Some of the burners were tried with different consumptions of gas.

NEW BATWING AND FISHTAIL BURNERS.

Kind of burner.	Cubic feet of gas used per hour.	Illuminating power in candles.	Illuminating power per 5 cubic feet of gas per hour.
Bray's No. 4 Fishtail	4.0	5.92	6.98
Same Burner	5.0	5.80	5.80
Bray's No. 6 Fishtail	5.0	9.70	9.00
Bray's No. 8 Fishtail	5.0	11.80	11.80
Same Burner	7.0	14.21	10.15
Brönner's No. 4 Batwing	4.0	10.10	12.62
Same Burner	5.0	11.60	11.60
Sugg's No. 4 Batwing	4.0	8.40	10.50
Same Burner	5.0	10.90	10.90
Batwing, with narrow slit	5.0	8.60	8.60
Batwing used in street lamps	5.0	11.60	11.60
Fishtail, with small platinum disk in flame	5.0	10.20	10.20
No. 5 Fishtail, metal top	5.0	7.50	7.50

It is difficult to get exact uniformity in the same kind of burner of each manufacturer, and the above burners may be inferior to others of the same kind. They were, however, selected at random. The results show that the best Argand burners produce upwards of one third more light from the gas than the best of the flat-flame burners, so that, taking light-producing properties alone into consideration, there is an advantage to this extent in favor of Argand burners. Bray's, Brönner's, and Sugg's are all good burners. It will be seen that Bray's No. 8 fishtail is much better adapted for burning the kind of gas experimented with than the No. 4 and No. 6 fishtail of the same maker.

The next table gives the results of my trials of various burners recently taken from fittings in houses in several parts of Newcastle.

BURNERS IN USE IN NEWCASTLE.

Kind of burner.	Cubic feet of gas used per hour.	Illuminating power in candles.	Illuminating power per 5 cubic feet of gas per hour.
Batwing, metal top	5.0	9.20	9.20
" " double slit	5.0	8.90	8.90
Fishtail, No. 3, metal top	3.5	4.10	5.85
" " steatite top	3.7	4.40	6.00
" "	4.0	3.00	3.75
" No. 4, steatite top	4.9	5.20	5.31
" No. 5, " "	5.0	7.80	7.80

It thus appears that burners are in use in Newcastle which give a light equal to only 3¾ candles, when burning the same quantity and quality of gas as, when burnt in a good Argand, will give a light equal to 17½ candles, or, if burnt in a good burner of its own class, will give a light equal to 12¼ candles, and such burners are very extensively used in Newcastle. Is it, then, a matter of wonder that we occasionally hear complaints of the bad quality of Newcastle gas? By the substitution of good burners for these wretched ones, from three to five times the amount of light will be produced from the same amount of gas; or, if the light of the present burners is sufficient, the same amount of light can be obtained from one third or one fifth the amount of gas. In the latter case, besides the saving in cost of gas, there is also the additional advantage of having the vitiation of the air in the room by sulphur compounds and carbonic acid from the burning gas reduced to the same extent.

It is in the hope that public attention will be called to this matter, and the wasteful misuse of gas prevented, that these results are now published.

NEW METHOD FOR THE QUANTITATIVE ANALYSIS OF SILVER.

THE method recently proposed by M. J. Volhard is based upon the circumstance that soluble sulphocyanide combinations with acid silver solutions form a white curd-like precipitate of sulphocyanide of silver. The same precipitate of sulphocyanide of silver is also obtained when silver solution is in the presence of the red solution of sulphocyanide of iron, the color of the latter disappearing instantaneously under the change. If, therefore, a solution of sulphocyanide of potassium or sulphocyanide of ammonium is added, drop by drop, to an acid silver solution, to which some sulphate of iron has also been added, every drop of the sulphocyanide salt solution creates a blood-red cloud, which, however, disappears upon the solution being shaken, the mixture assuming a pure milk-white color. It is only when all the silver has been precipitated as sulphocyanide of silver that the color of the iron and cyanide remains. If it is known how much sulphocyanide salt is necessary for the precipitation of a certain amount of silver, then it is easy to ascertain the exact quantity of silver contained in a solution.

This method is capable of being very generally employed, for it permits of bodies—such as chlorine, bromine, and iodine—being quickly and surely determined by precipitating them with silver solution of known strength, the excess of the added silver being titrated back again by means of a solution of sulphocyanide salts. Especially for the determination of the above elements in organic combination is the new process of Volhard to be recommended. The method has many advantages over Mohr's process, in which bichromate of potash is the indicator.

1. It is carried out with an acid solution, while with Mohr's process a neutral fluid is necessary, thus curtailing at once its utility.

2. The combination—the color of which serves as an indicator—is soluble, so that the retroaction is more easily known.

3. The salt serving as indicator (the sulphate of iron solution) is itself uncolored, and can therefore be added in larger quantities.

To make his titrating fluid, Volhard employs sulphocyanide of ammonium. As this salt is too hygroscopic, in order to weigh it in particular quantities the solution is put into a silver solution, obtained by dissolving 10 grammes of pure silver in nitric acid, and diluting to 1000 cubic centimetres. In another vessel a quantity of sulphocyanide of ammonium is dissolved in water, so that 8 grammes are contained in every litre of water. Ten cubic centimetres of the silver solution are put into a beaker, and to it are added 5 cub. cents. of a pure solution of sulphate of iron (a litre containing 50 grammes) together with 150 to 200 cub. cents. of water. From a buvette the sulphocyanide solution is gradually added, agitating the while, until the fluid has attained a feebie red tone. Assuming that for 10 cub. cents. of silver solution 9.6 cub. cents. of sulphocyanide solution have been used, 960 cub. cents. of the latter is diluted to 1000 cub. cents. One cub. cent. then shows 10 or 10.8 milligrammes.

Before use, this solution is again tested. With this object 1 gramme of pure silver is weighed, and this is dissolved in 8 to 10 cub. cents. of nitric acid; this is heated upon a sand-bath until no further trace of nitrous acid fumes are given off, and to it are then added 5 cub. cents. of iron solution, the whole being diluted subsequently with 200 cub. cents. of water. On cooling, the sulphocyanide salt solution is added, while the liquid is kept agitated. With the last drop of the hundredth cubic centimetre the red color must have set in visibly and permanently.—*Dingler's Polytechnisches Journal.*

[Boston Journal of Commerce.]

WHERE THE PRECIOUS METALS GO.

WHERE do the precious metals go—two hundred and nineteen millions of dollars of which are annually produced—is a question easily asked, and one that is easily answered. "'Tis the clime of the East, the land of the sun"—that parallelogram of the earth's surface included between the Red Sea, the Himalaya Mountains, the China Sea, and the Indian Ocean, inhabited by more than one half of the human race, and among whom paper money is unknown—which is absorbing and has absorbed for centuries a large amount of the precious metals. Rome, before the Christian era, imported carpets from Babylon, spices from Ceylon, silk (a pound of which was equal to a pound of gold) from Egypt, and precious stones and aromatics from India. The balance of trade due to the East from the mistress of the world, in the time of Augustus, was four millions of dollars annually—a sum which must be regarded as enormous, taking into view that at that time the relative value of silver to gold was only as nine to one; that the wages of labor and the prices of commodities were much lower than in our time; and that England and France were Roman provinces and inhabited by savage races, who dwelt in huts and painted their bodies, as our North American Indians did, seventeen centuries later, when the Puritans landed at Plymouth and the Cavaliers at Jamestown; when Germany was a land of forests, with a climate as cold as Canada in our time; and when Russia was a land of bogs and morasses, with its surface very little raised above the level of the Mediterranean.

In our time all the countries of Europe, as well as the United States, are large consumers of tea, coffee, sugar, spices, silk, hides, tin, dyestuffs, and other products of the East, which have to be paid for largely in gold and silver. The imports of the United States from countries beyond the Cape of Good Hope amount to sixty-four millions of dollars annually, while the exports to the Orient amount to but twenty-four millions. Great Britain and the other countries of Europe import annually one hundred and sixty millions of dollars more than they export to the same quarter. The exports of gold and silver from the United States, during the last twenty-eight years amount to fourteen hundred millions of dollars, a sum greater than the amount of the precious metals in existence two centuries ago. The Arabians, Persians, Hindoos, Chinese and Japanese consume but little of the products of the Occident, while the products of the Orient are in great demand by the people of Europe and America. A French writer says that the Egyptians conceal twenty millions of dollars annually of the precious metals, and the Emperor of Morocco has filled seventeen large chambers with gold and silver. The passion for hoarding is shared by the subjects of those princes. Silver pulpits and sacred ornaments of gold are very common in churches, temples, pagodas, and tombs throughout the Eastern Hemisphere.

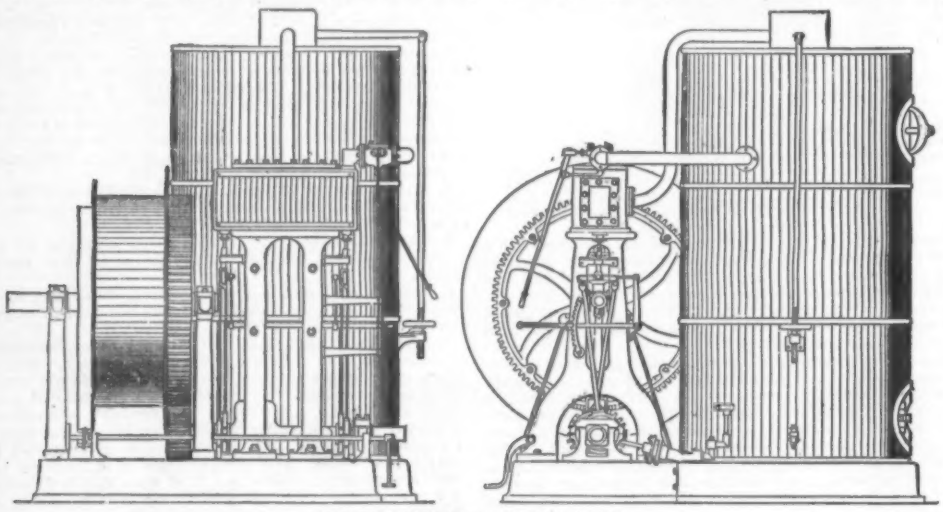
The solution of the problem of the disappearance of the precious metals from the countries where it is produced is, *that the Orient is the reservoir into which flows the gold and silver of the Occident*, a reservoir from which there is no reflux. It is with precious metals as it is with our sweetmeats—we can not have our cake and eat it too!

[Engineer.]

DOUBLE-CYLINDER WINDING-ENGINE.

WE illustrate above a very neat form of winding-engine, recently introduced by Messrs. Davey, Paxman & Co., of Colchester, Eng. It is a modification of the vertical engine exhibited at Taunton last year by this firm.

The starting valve-lever, reversing-lever, and brake-treadle can all be controlled by one man, without changing his position, at the same time he is able to see the pit's mouth while handling the engine. All the wearing parts are, where possible, made of steel or case-hardened. The slides are arranged to cut off at eleven sixteenths of the stroke, so as to insure the engine starting from any position in which it may stop. The eccentrics working the slides are cast together, and have large wearing surfaces. The crank-shaft is of wrought-iron, bent out of a solid bar. The pump is placed directly on the tank-base, from which it draws. The winding-drums are cast as two flange pulleys, and lagged between the flanges with 3 in. timber, and the spur segments are bolted directly on to the side, thus taking all strain off the drum-shaft. The



DOUBLE-CYLINDER WINDING-ENGINE.

brake-wheel is cast on the opposite side of the drum, and connected by a wrought-iron brake-strap to a lay shaft carried on the base, and which is worked by a treadle, a counterbalance relieving the drum when the foot is taken off. The whole engine and boiler are contained on one bed-plate, forming a water-tank, but, where desirable, the drums can be placed lower down or on independent foundations. The total weight of engine and boiler complete is 10 tons.

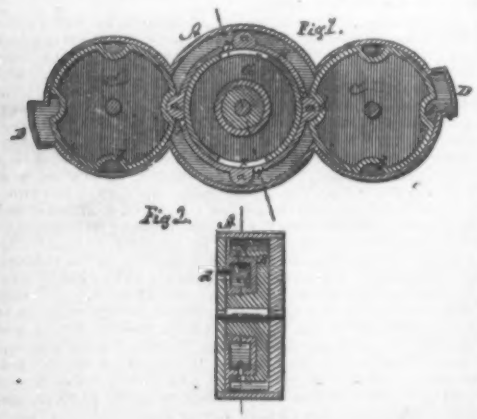
The principal dimensions are given in the following tabular statement:

Diameter of cylinders	10½ in.
Length of stroke	14 in.
Diameter of crank-shaft	4 in.
Diameter of drum-draft	5½ in.
Pitch of gearing	2 in.
Proportion of wheels	4 to 1
Diameter of drum	5 ft.
Width of drum	1 ft. 9 in.
Diameter of pump plunger	2½ in.
Stroke of pump plunger	3½ in.
Throw of eccentrics	3½ in.
Diameter of piston-rods	1½ in.
Diameter of slide spindles	¾ in.
Connecting-rod centres	2 ft. 8 in.
Diameter of brake-shaft	1½ in.
Diameter of brake-wheel	5 in.
Width of brake-wheel	4½ in.
Diameter of Paxman boiler	5 ft. 2 in.
Height of boiler	10 ft.
Total heating surface	320 sq. ft.
Diameter of steam-pipe	2½ in.
Diameter of exhaust	3 in.
Area of fire-grate	14 sq. ft.
Depth of base	12 in.
Thickness of boiler-plates	$\frac{7}{16}$ in.
Diameter of tubes	3¼ in.
Diameter of uptake	16 in.
Diameter of feed-pipe	1¼ in.

ROTARY ENGINE.

By J. C. TITUS, Marion, O.

A, the casing, receives the centre wheel B and two side wheels C C. The centre wheel B has four lugs *a a* on its



ROTARY ENGINE.

periphery, at equal distances apart, to fit in correspon ng recesses *b b* on the wheels C C as the wheels revolve.

The casing A is at each end formed with a pocket D, which becomes filled with steam, carried into it by the recesses *b* in the wheels C C. The steam in the pockets D D serves to balance the wheels C C by exerting a counter-pressure at a point opposite the point where the steam strikes the face of the wheel.

The centre wheel B is formed with an annular recess on one side, which fits snugly over an annular steam-chest G secured to the head of the casing. This steam-chest is, in its periphery, provided with two elongated ports *x x* opposite each other, and in the wheel B, behind each lug *a*, is a steam-port *y*, for the admission of steam. The steam enters the steam-chest through an aperture *y* in Fig. 2.

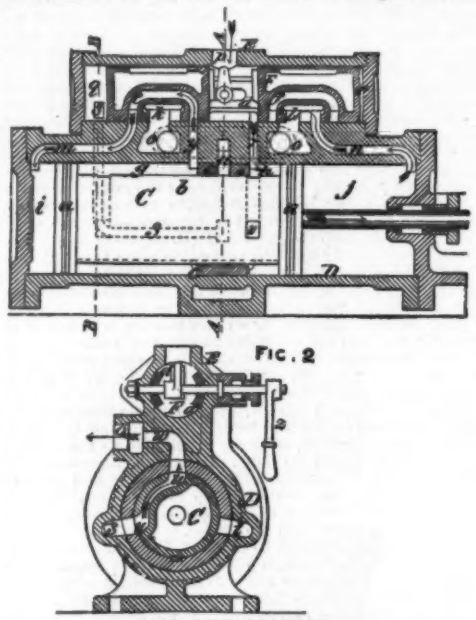
The length of time the steam acts direct is regulated by the length of the port *x*.

When the ports have passed so that there is no communication between the steam-chest and cylinder, the steam works on expansion until the next port, *y*, comes around to the port *x*.

IMPROVEMENT IN PUMPING-ENGINE.

By W. WALKER, Manchester, Eng.

C is the piston, which is formed with two heads, *a a*, connected together by means of a barrel-part, *b*. The said heads are made to fit the interior of the cylinder D, and are provided with packing or packing-rings in the usual or in a suitable manner.. At about the centre of the length of the said cylinder an annular partition, *c*, is fixed, the said partition being bored, and provided with packing to suit the barrel *b*, and the said barrel being turned and fitted to slide within the said partition in a suitably steam-tight manner. A key, fixed in the said partition, and entering a groove formed in the barrel *b*, prevents the said barrel from rotating. Other means may be employed to prevent such rotation, if preferred. The cylinder D is formed with a valve-chest or chamber, E, which is bored out to receive the slide-valve F, which is fitted to slide to and fro within the said chamber. The said valve consists of two parts, which are connected together at *d*, so as to form one casting; but, if preferred, the said valve may consist of two castings, suitably connected together. The two sections of the valve are formed with passages *e f*, which serve to establish communications for the flow of steam from the annular spaces *g h* to the end spaces *i j* of the cylinder, and with recesses *k l*, which, at the proper times, establish communication between the passages *m n* and exhaust passages *o*. The said valve is not required to be quite steam-tight within the chamber F, and therefore is not provided with packing-rings; but such rings may be employed, if thought to be necessary. Steam is admitted to the central space between the two sections of the valve through an opening at *p*, and part of such steam finds its way by leakage into the end spaces *q r*. A passage, *s*, formed in the cylinder-casting, extends from the space *q* to a port formed in the partition *c*, as represented by the dotted lines in Fig. 1. A similar passage, *t*, extends from the space *r* to a second port formed in the said partition; but as the said passage is formed in the part which is represented as being cut away in Fig. 1, it does not appear in the said figure. Two passages, *u* and *v*, are formed in the barrel *b* in such a manner and in such positions as that, when the piston C approaches the termination of its stroke in either direction, one of the last-named passages will connect the passage *s* or *t*, as the case may be, with a passage, *w*, which extends into the exhaust-passage, the effect being that steam will flow from the space *q* or *r*, as the case may be, into the said exhaust-passage, and the equilibrium of pressure upon the ends of the valve being thereby disturbed, the said valve will be moved in the direction toward the space which has been so exhausted. Supposing the parts to be in the positions as represented in the drawings, high-pressure steam would be flowing through the port *x* into the annular space *h*, and at the same time the steam which had acted during the immediately previous stroke would be flowing through the port *y* and passages *e* and *m* into the space *i*, into which space the said steam would expand, and the piston would therefore be propelled in the direction indicated by the arrow, the exhaust-steam flowing from the space *j* through the passages *u* and *l* into the exhaust-passage *o*. The movement of the piston in the said direction would continue until the passage *n* in the piston had moved into position to connect the two passages *s* and *w*, in manner as seen in Fig. 2, when steam would flow from the space *q* into the exhaust-passage *o*, and the excess of pressure within the space *r* would force the valve toward the end of the valve-chamber marked *q*. The effect of this movement of the valve would be to open the port *y* for the admission of high-pressure steam into the annular space *g*, and to establish a thoroughfare for the flow of expanding steam from the annular space *h* through the passages *x*, *f*, and *n* into the space *j*, the passage *m* being caused to communicate with the exhaust-passage *o*, whereby the reversal of the direction of motion of the piston would



NEW PUMPING-ENGINE.

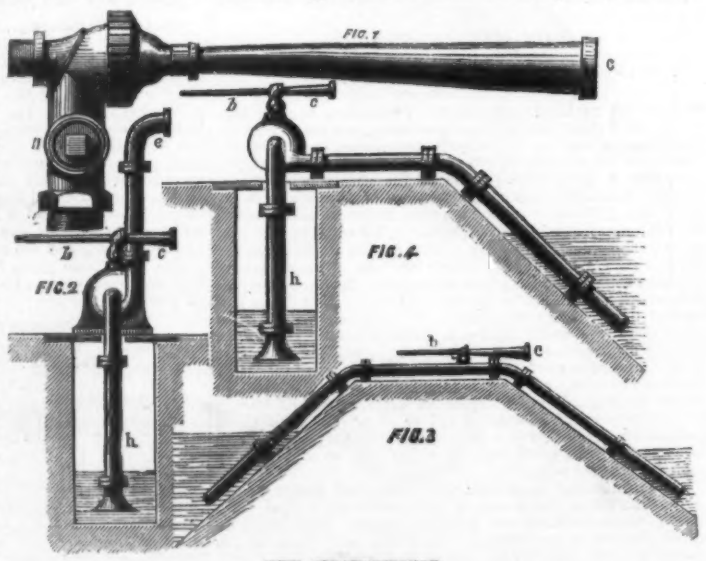
be effected. A starting-handle, *z*, is provided in order that the valve may be worked by hand when the pump is to be set in motion after being at rest. The said handle is mounted on a rocking-shaft, on which is fixed or formed a lever, which gives motion to the valve when the shaft is rocked by means of the said handle.

NEW STEAM-EJECTOR.

THE steam-ejector of Nagel & Kaemp is mainly designed for centrifugal pumps, water-raising pipe systems, and other purposes, dispensing in centrifugal pumps with the use of the bottom valves.

One of the objections of centrifugal pumps lies in the difficulty of first filling the same, which produces frequently interruptions in their working. It is true that this difficulty does not occur when the pump and casing are submerged, but the application of the pump in this manner is not of frequent occurrence. A bottom valve is generally employed to enable the filling of the pump, but this valve is objectionable, as it retards the passage of the water and does not close tightly in impure water. Further, it is obvious that with the size of the pumps, the size of the suction-pipes and valves, and consequently the difficulty of keeping the latter tight, increases. The interruptions in the working of the pump caused thereby are the more annoying as the valve has to be below the water-level, and is thereby more or less inaccessible.

The ejector, Fig. 1, is designed to overcome the defects mentioned, and consists simply of a pipe, that exerts a suction by means of steam passing through the same. The application of the ejector to centrifugal pumps is shown in Fig. 2, where the apparatus is screwed to the highest point of the



NEW STEAM-EJECTOR.

pump-casing. One end of the ejector is connected by a pipe with the boiler. To fill the pump, the opening of the conducting-pipe is closed, and the stop-cock H (Fig. 1) opened. Steam is then admitted to pass through the horizontal ejecting-pipe *c*, so that the air is first drawn out from pipe A and the pump-casing, producing a vacuum, which causes the rising of the water until it is high enough to condense the steam, entering at *b* and be forced out at *c*. This indicates that the pump is filled, so that the same may be run instantly at normal speed, after opening the conducting-pipe and closing the cock H. The steam-pipe may then be shut off near the boiler to prevent waste of steam by condensation.

In Fig. 3 the application of the ejector is shown to pipes for raising and conducting water, the device serving in this case to liberate the air collecting at the highest point of the

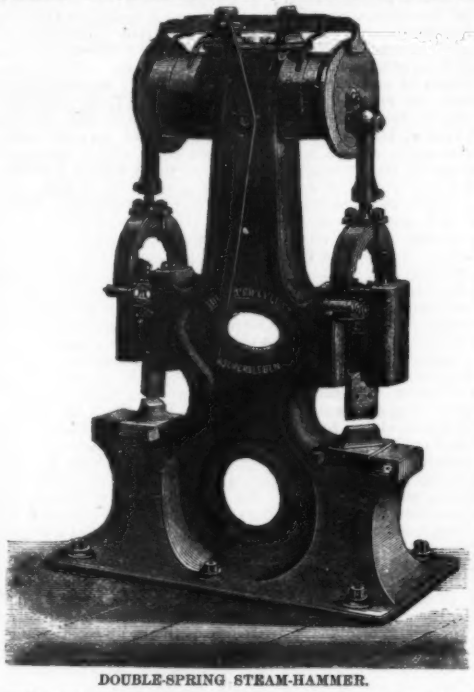
pipes, and to prevent the interruption of the working of the pipes.

Fig. 4 shows the combination of centrifugal pump and water-elevating pipes, in which the ejector is kept continuously at work so that the working of the pump is facilitated, as it is not required to pump higher than the absolute difference by the upper and lower water-level.

DOUBLE-SPRING STEAM-HAMMER.

FOR some years past steam and spring hammers of American origin have been introduced into Europe and used with satisfaction.

An example is shown in our engraving, made by Billeter & Klunz. It is a double hammer, which serves at once for



DOUBLE-SPRING STEAM-HAMMER.

drawing out and smoothing. With a weight of about 66 lbs. and a range of 8.89 in., each hammer gives about 180 blows a minute, and requires scarcely half a horse-power of moving force. The two hammers are independent of each other. There is a saving of manual labor to the extent of 50 per cent.

ROTARY PUMP.

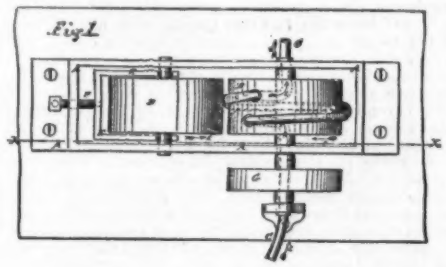
By W. T. DOREMUS, New-York.

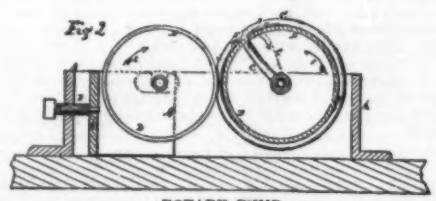
THE fluid is forced through a flexible tube coiled around the face of a cylinder, the tube receiving and discharging its fluid through the hollow journals of said cylinder by the pressure upon said tube of a second cylinder.

A, frame in which revolves a cylinder, B; its journals are hollow to receive a flexible tube, C, made of rubber, which passes in through one journal, passes out through a hole or notch in the shell of cylinder B, makes a little more than one turn around it, passes in through a hole or notch in its shell, in through a hole in its hub, and out through its other journal.

The tube C should be swivelled at the ends of the journals of the cylinder B, to prevent it from being twisted by the revolution of said cylinder, and should have a check-valve in its discharge end, to prevent any back flow of the fluid.

The part of the tube C that passes around the cylinder B may be round or flattened, or of any form not liable to be injured by compression.





ROTARY PUMP.

The flexible tube need not pass through the journals of the cylinder B, but may be connected with the hub of said cylinder, and the fluid received and discharged through its journals, with the outer ends of which the inlet and discharge pipes may be connected by swivelled joint or otherwise.

D, a cylinder, revolving in a frame, E, that slides in the frame A, and has a swivelled screw, F, connected with it, so that it may be adjusted to press the tube C against the face of the cylinder B with any desired pressure.

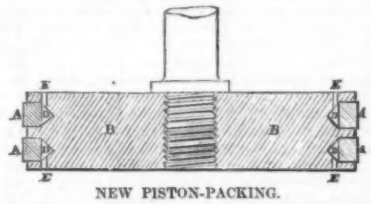
As the cylinders B D are revolved the tube C is compressed between their faces, which forces the fluid in front of the point of contact out through the discharge end of the tube C, and forms a vacuum in the rear of said point of contact, into which the fluid is forced by atmospheric pressure, so that there will be a continuous discharge of the fluid from the discharge end of said tube C.

NEW PISTON-PACKING.

By M. PAUL GIFFARD, Paris, France.

CONSISTS of a circumferential groove cut into the piston, into which a band of leather or caoutchouc is made to fit tightly. The bottom of the circumferential groove is V-shaped, and thus forms a hollow behind the packing-band. Into this hollow steam enters and drives the packing-ring against the surface of the cylinder, securing perfect tightness of the piston without thereby increasing the friction to an excessive degree. The holes for the admission of the steam to the back of the piston-ring are drilled from the upper and under surface of the piston. The band of leather or caoutchouc is so fitted into the groove that it is without play—with the greatest possible tightness, and the ends overlap each other by gradually thinned surfaces.

The annexed diagram illustrates a piston of double effect, as M. Giffard describes it: A is the packing-ring, D the hollow behind, and E the passage for the steam. In this case, as will be seen, there are two rings, the piston thus being automatically fitted in both up and down strokes. For use in steam-engines a metallic band, or ring, and an elastic band are placed in the groove, the metal and rubber being in close contact. Other packings may, however, be used, such as

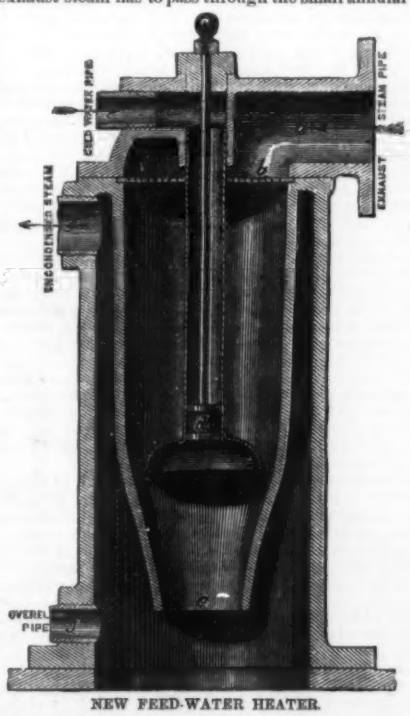


NEW PISTON-PACKING.

leather, rubber in one thick or several thin bands, hemp, gasket, wood, compressed paper, and other suitable materials; but it is important to keep the channel or groove D as small as possible, and to make the holes E for the admission of steam, in no greater number and no larger than is required to allow the steam to exercise the desired effect as soon as possible. That this system of packing-pistons is a good one can not be doubted, but it may be questioned whether it is of such excellence as to cause any great demand for it. M. Giffard says that "the mode of construction is entirely new, extremely economical, easily adapted, and the wear compensated. It is also infallible in its working, lasts a long time, can be easily and quickly renewed, enables a cheap piston to be obtained, having the minimum amount of friction, and such an absolute hermeticity, or proper tightness, as to enable cent per cent of the volume of gases, fluids, or steam to be utilized."

NORTHCOTT'S NEW FEED-WATER HEATER.

THE arrangement will be readily understood from our engraving. The exhaust steam enters at the branch *a* and passes through a horizontal perforated plate *b*, below which it comes into contact with the feed-water to be heated, this water entering through the branch *c*, and being discharged in a number of fine streams through holes formed in the central pipe shown. This pipe is fitted with the piston *d*, which piston can, by means of the rod shown, be slid up and down so as to adjust the supply of feed-water. The feed-water in contact with the exhaust steam has to pass through the small annular space



NEW FEED-WATER HEATER.

around the bell at the lower end of the central tube, and falls through the nozzle *e* into the tank on which the heater is placed. This tank serves to contain a supply of heated water, and it is placed slightly above the level of the feed-pump. In it, too, the heated feed-water deposits some of its impurities, these settling down and being cleaned out at convenient intervals. It is recommended that the supply of feed-water should be so adjusted that there is always a small escape at the overflow pipe *f*, this overflow thus carrying off any oil or tallow which may rise to the surface. This heater is capable of raising the temperature of the feed to 210 deg. or 212 deg. and it is altogether a very neat and compact arrangement.

BOILER-COVERING.

THE invention of Messrs. Beamich and Mason, of Liverpool, consists essentially of a combination of lagging and cement, so as to obtain the advantages of both. The laths are placed a few inches apart on a surface of cement, the laths being pressed into the cement till the surfaces of the two materials are flush with each other.

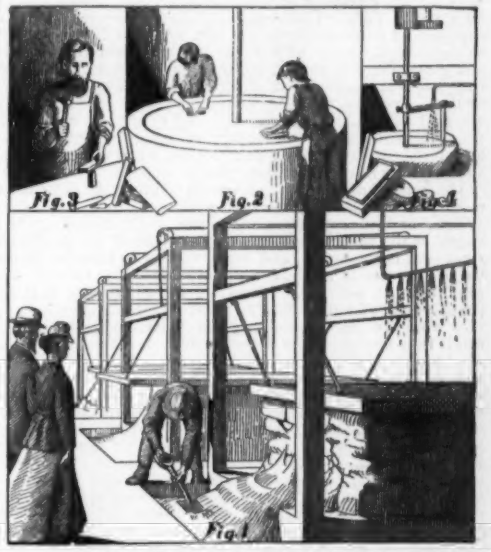
THE MANUFACTURE OF OIL-STONES.

By H. Y. BEACH.

UNTIL recently the principal supply of oil-stones was brought from Turkey, though the Hindostan stone, the Norway rag-stone, the Welsh stones, and others were to some extent used. A specimen of Turkey stone of uniform texture is rare. The Hindostan stone when in use quickly fills with metal, and nearly all the kinds enumerated have some serious defect. The European varieties are now superseded by the "Whetstone Rock" from Arkansas, which fulfills better than any other the difficult requirements of an oil-stone. It is of uniform hardness. It is somewhat porous, yet the pores do not retain metallic particles. Its surface does not wear concave, and it possesses extraordinary resisting properties, the sharpest point of the file instantly wearing flat upon it, without causing a scratch. According to Professor David Dale Owen, the chemical analysis of the Novaculite Rock (Washita or Arkansas stone) shows the composition to be as follows:

Silica	98.00
Alumina	.80
Potash	.60
Soda	.50
Lime, Magnesia, Hydric Fluoride, Water	.10
	100.00

Messrs. Boyd and Chase of New-York are the most extensive manufacturers of this stone. They obtain their supply from Hot Springs, Arkansas, the only locality known that contains this peculiar variety. The finer quality is called Arkansas stone; the coarser, Washita. Arkansas stone is the harder, and resembles white marble. Lumps of Arkansas stone without flaw are seldom found more than eight inches long, and they are often traversed by thin quartz veins. Where these veins occur, the stones must be cut to avoid them, for the surrounding stone, being softer than the quartz, is worn away by the polishing process more rapidly, leaving the quartz projecting above the surface, and liable to destroy any cutting edge which may strike it.



THE MANUFACTURE OF OIL-STONES.

Washita stone is softer and more porous than the Arkansas. It is found in larger masses, is cheaper, and seldom contains quartz.

The accompanying diagrams illustrate the process employed by Boyd & Chase for cutting and polishing oil-stones. Fig. 1 shows the gangs of saws, each gang requiring a four-horse steam power, and cutting about one thousand pounds of Washita stone per day, and about sixty pounds of Arkansas stone. The fragments of rock are packed upon the bed of the saw-frame. The saws have a reciprocating motion, and rise at the end of every stroke. The sand and water which are thrown upon the saws then flow down between the saw-edges and the stone beneath. The saws are of soft iron, and when they descend at the beginning of the next stroke, the sand is imbedded in the metal and cuts the stone as the saws move.

After being sawed into slabs, the stones are piled under another gang of saws, by which they are cut into proper widths. Their ends are then squared in such a manner as as to avoid flaws and quartz veins (Fig. 3). To cut beveled surfaces the slab is held in an inclined position under the saw by means of plaster-of-Paris.

Lastly, the stones are finished on a large horizontal cast-iron wheel or revolving table, covered with sand and water (Fig. 2). The workman presses the stone upon the wheel, which revolves with great velocity, and polishes the stone by means of the sand.

Fig. 4 represents the machine employed to cut wheel-stones. The lower end of the shaft is shaped like a gouge chisel, and cuts the core. The periphery of the wheel is cut by a soft iron, bent to form an arc of the circle it describes, and its corner rounded to permit the sand to flow under. The wheel-stones usually range from one inch to three inches in diameter. So rare is a large piece of Arkansas rock without flaw that the cost of a wheel nine inches in diameter would reach several hundred dollars.

Mr. Chase has employed several methods of sawing with diamonds, but he eventually found their use inexpedient. The diamond cuts as much in twenty minutes as the sand can in a day, but so wonderful is the abrading property of this stone, that even diamond points are worn smooth after a few minutes' use. So great is the necessary strain that the strongest saws set with diamonds double up, and the diamonds are frequently forced from their settings or broken.

The excellence of the Arkansas and Washita stones is attested by the number exported to all parts of Europe. Their shapes and uses are quite varied. Stone files are made pointed, knife-shaped, cylindrical, and in the shape of triangular prisms, for dentists, jewelers, and watchmakers; also, stones to sharpen surgical, mathematical, and engravers' instruments, and for penknives, needles, and all kinds of wood-working tools.

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THE INTERNATIONAL EXHIBITION OF 1876.

THE CORLISS ENGINES AND BOILERS.

No. VI.

AT the first glance one is tempted to conclude that they are by no means a handsome piece of work, and particularly as in such a place and for such a purpose most people, engineers as well as others, naturally look for a more than ordinary display of those features in design which are so often introduced merely to give a pleasing appearance to the eye. In structures of this kind, and particularly in the stationary-beam engine, there is almost always seen more or less of a straining after architectural and other ornamental effects. We very often find an engine-frame made up of elaborate Corinthian or Gothic columns and arches, thoroughly misplaced as such, as well as graceful curves in struts and braces which every engineering consideration would decide should be straight lines. The disappointment, however, which is experienced momentarily at the lack of this kind of beauty in the general outline of the machine very soon gives way—and particularly to the engineer, when he comes to see how completely and severely practical fitness has been adhered to, and he concludes that the material in it has been "placed where it will do the most good." As this latter consideration constitutes the true standard of beauty in engineering structures, we arrive, without ratiocination, at the conclusion that they are a truly handsome pair of engines.

The general design of the frame is a simple **A**, or perhaps more nearly an isosceles triangle, with the beam-centre at the vertex, and the cylinders and main shaft occupying the angles at the base. This form reminds one of the American river-boat beam-engine, and many will regret that the skeleton or truss-beam, so universally seen upon that class of engine, has not been used in these; for while they will be proudly pointed out as specimens of American engineering, they would be more thoroughly and characteristically American if they possessed this almost generic feature. The principal members of the frame are of the hollow or box form now so widely used in heavy machinery. There is one peculiarity in it, however, which amounts almost to an innovation: everywhere possible the corners—instead of being simply rounded, as has come to be the prevailing style with builders of heavy machinery, and which is altogether of English origin—are merely flattened for about one quarter of the width of the four sides, making an approach to the octagonal form of section. As this feature is carried out even to the smallest unfinished member of cast-iron, it becomes a positive novelty, and one—so far as is discernible before the final painting, etc., is done—which will be approved by engineers generally. The longitudinal deviations in rounded corners, inseparable from the best of castings, reflect the light in such a way as to produce a much more disagreeable effect than equal inequalities upon these narrow, flat surfaces; so that while these frames, as specimens of casting, will really equal any thing in the building, this feature lends them an additional air of finish and fine workmanship.

Another peculiarity in these machines is the form of all the cast-iron lenses, bell-cranks, etc, which transmit the motion of the eccentrics to the valves. Here again a kind of fundamental design has been adhered to, and is as precisely the opposite to that of the frame as could well be imagined, although not any the less theoretically correct in form for the work they have to perform. The strains upon the frame, being almost solely in the direction of their length, are properly straight, while transverse strains, such as these lenses and cranks sustain, admit of curved outlines, as in a parabolic beam, for instance, which, however, is also governed by the form of transverse section. These cranks and levers all have a more or less modified form of the letter **S**, according as the particular piece could be made to conform to that outline, while a transverse section through any of them, except at or near their ends, has the form which would best be described as a section of a parabolic spindle. It will thus be seen that, precisely unlike the frame, which is composed rigidly of flat surfaces and right lines, these moving parts have nowhere a flat surface, nor can a straight line anywhere be traced upon them. Add to this that they are highly finished on every particle of their surface, and the contrast with the frame becomes complete. With the engines making 55 turns per minute, these bright, squirming-looking objects will bob about upon the unfinished background of the frames something like a lot of silver-fish in some novel kind of aquarium. The magnificent 30-foot gear-wheel looms up gradually since the scaffolding is removed, and is the admiration of every beholder. This is said to be the largest cut iron gear in the world. It weighs 56 tons, and when in motion, with its periphery travelling at the rate of about 3400 feet per minute, or over 42 miles per hour. If it runs in noiseless contact with its iron pinion, as is claimed, it will prove a marvel of refinement among even modern perfections of workmanship.

The crank-shaft carrying this wheel is 19 inches in diameter, and is made of the best hammered iron. The bearings are 18 inches in diameter and 27 inches long. The cranks, of gun-metal (iron), are polished all over except in the recesses on the back, and weigh over 5 tons each. The beams are 9 feet wide in the centre, 27 feet long, and weigh each about 11 tons; they are also of quite novel form. The connecting-rods, now that they are in place, have the appearance of being rather light, but this comes no doubt from the massive look of the beams, which have a more ponderous appearance than is their due on account of their unusual depth at the centre. In order to have these connecting-rods of as perfect material as possible, they were built up entirely of wornout horseshoes, of which there were used in their construction no less than about 10,000. They are 24 feet long. The piston-rods are steel, and 6¼ inches in diameter.

If high piston speed is a factor in the economical use of steam, the full advantage of it will be had in these engines, for they will move at the unprecedented mean velocity of about 700 feet per minute, while their maximum speed will be over 1100 feet per minute.

The Corliss valves and valve-gear are too well known to need to be described here. The weight of the entire pair of engines and shafts immediately connected to it is over 700 tons.

The engines are surrounded by a circular platform 55 feet in diameter, raised 3½ feet, and such is the position of these machines that the tops of the beams are 40 feet above the floor of the Hall. They are also provided with iron stairs and platforms leading to their several parts in such a manner as to make them everywhere accessible without detracting from the general appearance of the machines.

The boilers are twenty in number, rated at 70 horse-power each, and are exactly alike in all respects. They are plain cylinders having tubes running through their entire length arranged in two nests, so as to leave a space across the centre in width about one third of the diameter without tubes. Opening into this space, and located at the centre of their length, are two trunnion-like castings, placed on opposite sides and closed with flat bonnets which serve as man-hole plates, and are bolted on. The boilers are placed vertically, and upon the bottom tube-sheet, which is in most direct contact with the fire, is placed a kind of shallow pan extending across the tubeless space, and raised a short distance from the tube-sheet; this is intended to collect the mud and sediment from the water. The boilers are entirely surrounded by brick-work, which extends some distance above the upper tube-sheet, and is covered by a cast-iron cap having perforations in it exactly corresponding in position to that of the boiler-tubes; on each of these openings is placed a loose cap to keep them closed except when necessary to sweep the tubes. When this operation is required to be done, these caps may be removed one at a time, while the fires are burning and the boilers in operation, and thus the cleaning of the tubes can be done at any time, and as often as may be desired, without interfering with their continuous use where necessary. Some of these boilers have been in constant use for eighteen months without once stopping for the purpose of sweeping flues.

The brick-work surrounding them leaves a space between it and the sheet of the boiler except for a short distance at the centre of their height, where it is contracted to contact with the outer shell at its whole circumference. At this point the boilers are supported upon the trunnion-like castings alluded to above. With this arrangement nearly the entire lower half of the boiler is subjected to the more or less direct action of the fire, whence the hot gases pass upward through the tubes, are deflected downward by the iron cap of the brick-work, and again come in contact with nearly the upper half of the shell, finally making their exit through a flue leading from just above the line of contact of the brick-work and shell into the chimney; thus almost the entire boiler, inside of flues and outside of shell, constitutes effective heating or superheating surface. The water-line is carried at about ⅔ of their height from the lower tube-sheet, which gives nearly ¼ of the whole surface to the super-heating of the steam.

The circulation of the water in these boilers must also be very perfectly carried on: the water surrounding the tubes on each side of the centre receives the greatest heat; in these parts of the boiler there must always, therefore, be ascending currents, which, curving inward, descend in the central space devoid of tubes, meeting the sediment-collector at the bottom, where they will become sufficiently quiescent to deposit whatever insoluble particles they may hold in suspension, while the rapid circulation and renewal of the water, coming in contact with the lower tube-sheet and the hottest parts of the tubes and shell must prevent the deposit of the ordinary scale from water holding the constituents of such in solution.

The feed and blow pipes enter the boilers through the man-hole plates, the latter extending downward inside the boiler to near the bottom or sediment pan, in order to remove the sedimentary matter when blowing off.

The upper tube-sheet is made in two pieces and riveted to a casting which occupies the tubeless part of the head, from which a nozzle or pipe is led for connection to the steam-pipes. Upon each of these nozzles is placed a safety-valve, outside of which is a stop-valve, by means of which any boiler may be shut off from the rest, its own safety-valve still being in connection with it. From these nozzles are led cast-iron pipes, which, passing downward in front of the visitors' platform, converge, to connect with the main steam-pipe beneath the platform. This pipe is 18 inches in diameter, of boiler iron, and double riveted; it runs 320 feet to the engine in the upper part of the covered way leading from the boiler-house to the engine.

The brick-work of the boilers are encased in sheet-iron jackets for a little over half their height, and the cast-iron cap-pieces have flanges turned down over the brick-work, with pointed projections upon their simulating boiler-rivets. The fire and ash pit doors are hung upon this casing, which forms a kind of corrugated wall surrounding the fire-room. There are two fire-doors to each boiler, opening upon circular and independent grates. Altogether the fire-room and arrangement of boilers and furnaces form the most complete and accessible arrangement as well as the neatest and most orderly-looking place of the kind ever seen by the writer.

These engines and boilers, as a whole, will be regarded as a master-piece of mechanical engineering, and will add greatly to the professional reputation of the already well-known name of Corliss.

J. T. H.

PROCEEDINGS OF SOCIETIES.

ZOOLOGICAL SOCIETY OF LONDON, MARCH 7.

DR. A. GÜNTHER, F.R.S., in the Chair.—The Secretary drew special attention to the hornless deer of China, named *Lophotragus michianus* by Mr. Swinhoe, of which the first living example seen in Europe has lately been received at the Society's Gardens. Dr. Günther exhibited specimens of a small marsupial animal, *Antichinus minutissimus*, which fills the place of the shrews in the Australian fauna. Mr. A. H. Garrod described the anatomy of *Aramus scolopaceus*, which he considered to be closely allied to the cranes. A paper by Mr. T. E. Buckley "On the Past and Present Distribution of the Larger Mammalia in South Africa," showed how the range of most of the species had been reduced by the persecution of man, many species being now quite extinct in districts where they were formerly abundant. Dr. Spencer Cobbold, F.R.S., read the fourth part of his Memoir on Intestinal Worms. Sir Victor Brooke, Bart., made some further observations on the remarkable deer from the Persian Gulf, which he lately described under the name of *Cervus mesopotamicus*, and also exhibited a pair of deformed and curiously heavy antlers of *Cervus schomburgki*, which he believed to have been the result of injury to the reproductive organs of the animal during the growth of its horns.

SOCIETY OF BIBLICAL ARCHÆOLOGY, LONDON, MARCH 7.

DR. S. BIRCH, President, in the Chair.—The following papers were read: I. "On the Mammalia of the Assyrian Monuments: (Part I.) Domestic Mammals." By the Rev. William Houghton. In this paper the author, after alluding to the interest of the subject, spoke also of its difficulty, for names alone often failed to convey a definite meaning. Animals may be represented in three ways: 1. By pictorial or sculptural representation; 2. By description; 3. By picture and description combined. Applying his remarks to the animals figured or mentioned on the Assyrian monuments, he stated that the pictorial or sculptured representations are so good as in most cases to speak for themselves. Of representations of animals and description founded on a zoological basis, the monuments afford no instance. There may have been Assyrian Aristotles who wrote on natural history. The bilingual tablets containing the names of animals, trees, stones, etc, show a sort of natural order, which the scribe observed for convenience sake; but these tablets were only part and parcel of Assurbanipal's grand idea of forming a complete comparative dictionary and grammar of the Assyrian and Accadian languages. Mr. Houghton referred to the prevalent custom among the Accadians of naming animals from the countries from which they came; thus the horse was the "animal from the east;" the wolf, "that from the high-lands." The third method of representing animals by sculpture and description combined—the most certain of all—though frequently to be seen in the hieroglyphic system of the ancient Egyptians, was not adopted by the Assyrians. In attempts to discover the name of any particular animal, the Assyrian word must be compared with some similar word in Hebrew or other cognate Semitic language; identity of word often implies identity of meaning. Sometimes the context afforded a clue. In the bilingual lists the Accadian equivalent to the Assyrian name often threw much light; but unfortunately the tablets were often broken. The domestic animals known to, or employed by, the Assyrians were oxen, sheep, goats, camels (both the Arabian and Bactrian species), asses, horses, mules, and dogs; on each of these subjects Mr. Houghton spoke at some length. Only two kinds of dog appear on the sculptures—the large mastiff used in the chase of the lion, wild bull (the *rêm* of the Hebrew Bible, *rîmu* in Assyrian), wild asses, etc., and the greyhound. On the question as to the domestic cat being known or used by the Assyrians, Mr. Houghton, in his own mind, was satisfied a negative answer should be given. As there was intercourse between the Assyrians and Egyptians from early times, he admitted there was no *d priori* objection to the belief that the Egyptian cat, which he considered the origin of domestic cats wherever found, might have been introduced into Assyria. Mr. Houghton thought it improbable that the cat was domesticated, seeing that in other countries it was long before it was introduced. The Egyptians preferred to keep their cats to themselves, to nourish them when alive, to embalm their sacred bodies at Bubastis or elsewhere when dead.

ROYAL ASTRONOMICAL SOCIETY, MARCH 10.

DR. HUGGINS, President, in the Chair.—Dr. Royston-Pigott described a starlit transit eye-piece, in which the illumination of the field was dispensed with, the usual spider-line diaphragm being replaced by a glass diaphragm silvered thinly on one side, with a set of parallel fine lines ruled on the silver. The star in its passage across the field would flash out brightly when it came to one of the lines where the silver had been scraped away, and the instant of this flash could be noted by ear to the nearest tenth of a second. The film of silver being extremely thin, moderately bright stars could be seen faintly through it, and their course across the field watched. Lord Lindsay remarked that though there might be some difficulty about the observation by ear of the instantaneous flashing of the star, yet the eye-piece was likely to prove very useful for equatorial observations. Capt. Abney then read a preliminary note on the method of photographing the red rays of the solar spectrum, announcing the important discovery that the addition of a resin to the collodion would render it sensitive to the red rays, and that consequently the results obtained by Dr. Vogel, and more recently by Captain Waterhouse, who stained the photographic film with an anilin dye, were due to the fact that the dye was a hydrocarbon, and not to any absorption dependent upon its color. By the use of a resin Captain Abney has made a great advance even on Captain Waterhouse's results, obtaining by a moderate exposure (ten minutes) photographs which show the spectrum as far beyond the extreme red line A as that is from the yellow sodium line D. Dr. Huggins, on behalf of the meeting, thanked Captain Abney for his communication, which would prove of the greatest importance in spectroscopic observations. Mr. Dunkin read a note on a supposed case of variable proper motion which, from a discussion of recent observations at Greenwich combined with older measures, he held must be given up, and in this view he was supported by a communication from Mr. Stone, who found that the star had been observed at the Cape in 1837. The Astronomer Royal congratulated Mr. Dunkin on having got rid of an astronomical mare's nest, and pointed out the importance of making repeated observations of the same stars in different years. Captain Noble called attention to a paper by M. Normand on "Occultations of Stars by Planets," and appealed to the possessors of large telescopes to try the feasibility of the plan (which is proposed for determining the parallax of Mars next year) on the planet Jupiter at its approaching opposition this summer.

ROYAL GEOGRAPHICAL SOCIETY, MARCH 13.

SIR RUTHERFORD ALCOCK, K.C.B., presided in the absence of Sir Henry Rawlinson, who had been summoned to Windsor. The first paper, by the Rev. Dr. Mullens, Secretary of the London Missionary Society, gave an account of an ascent up the Fly River, on the coast of the Gulf of Papua, by the Rev. S. Macfarlane, of the same society. Mr. Macfarlane and his party, which numbered fourteen, and included M. D'Albertis, the Italian naturalist, had started from Cape York on November 29th last, and succeeded in ascending 170 miles up the Fly River, being 100 miles further than any one had previously penetrated. At that point the river was four fathoms deep, and so well adapted for purposes of navigation. The surrounding country was flat, swampy, and uninviting for settlers, the mangroves frequently extending inland from the banks upwards of a mile. The natives met with showed a hostile front, and, clad in full war costume, proceeded to discharge spears and arrows at the vessel. After vain endeavors to conciliate them, some shots were fired across the bows of the first canoe, and this proving ineffectual, a charge of

dynamite was exploded below water, which caused the greatest consternation. A further progress up the river was stopped by the fact of the *Ellangowan* breaking the shank of her propeller.

The second paper furnished an account of Mr. Octavius C. Stone's explorations in the interior of New Guinea, from Port Moresby, in the east part of that island. It brought to notice the fact that the country was extremely fertile, and the natives of a superior character to the coast tribes, and well disposed and friendly to white men. It was greatly to be wished that no kidnapping parties would be allowed to exercise their nefarious traffic there, and so raise a bar against the possibility of future friendly intercourse between the two races. In the short discussion which followed admiration was freely expressed at the successful manner in which Mr. Macfarlane had journeyed into the interior without bloodshed.

INSTITUTION OF CIVIL ENGINEERS.

ON March 21st a paper was read descriptive of "The Hydraulic Canal Lift at Anderton, on the River Weaver," by Mr. Sidengham Duer, B. Sc., Assoc. Inst. C.E.

The object of this lift was to transfer floating barges between the Trent and Mersey Canal and the river Weaver, and thus to afford an easy and expeditious means of communication between them without the expense and delay hitherto incurred in transhipping goods. The idea of lifting the laden barges by hydraulic power originated with Mr. Edward Leader Williams, Jr., M. Inst. C.E., at that time engineer to the trustees of the Weaver Navigation. He consulted Mr. Edwin Clark, M. Inst. C.E., on the subject, and after various designs had been considered, the arrangement of the details and the superintendence of the construction were entrusted to the author. The canal and river were close together at Anderton, but the level of the water in the canal was 50 ft. 4 in. above that in the river.

The water of the canal was conducted by a wrought-iron aqueduct, 162 ft. 6 in. long, across an arm of the river to the end of the lift. This aqueduct was in three spans, of 30 ft., 75 ft., and 57 ft. 6 in. It was 34 ft. 4 in. wide, and a central web divided it into two channels, each 17 ft. 2 in. wide. This central web and the sides of the aqueduct were 8 ft. 6 in. deep, and formed continuous girders, which carried the aqueduct and the water, 5 ft. 3 in. deep, contained within it. The total weight of the aqueduct and the water was 1050 tons, or about 6½ tons per lineal foot. Excepting at the end, where it rested on the masonry of a basin leading into the canal, the aqueduct was carried on cast iron columns.

The lift was double; each half consisted of a wrought-iron trough 75 ft. long and 15 ft. 6 in. wide, capable of containing barges floating in water 5 ft. deep. The sides of the trough were 9 ft. 6 in. deep at the centre, and 7 ft. 6 in. deep at the ends, and formed girders to carry the weight of the trough, water, and barges, which amounted to 240 tons. This weight was transmitted from the sides to the head of a central ram, 3 ft. in diameter, by cantilevers which radiated from the ram to the sides of the trough. The trough was thus supported and moved up and down by one central vertical ram, which worked in a press sunk within a cast-iron cylinder below the bed of the river. The pressure on the ram amounted to about 4¾ cwt. per square inch. The trough had a lifting gate at each end, for the ingress and egress of barges, and there were corresponding gates in the aqueduct, so that boats could pass between the aqueduct and the trough according as they were to be lowered or had been lifted. The press under one trough was connected by a pipe, 5 in. in diameter, with that under the other trough, and thus water contained in one could pass freely into the other, by an equilibrium-valve in this pipe. There was also a small steam-engine continually pumping water into an accumulator, to assist in the working of a lift. Piping 4 in. in diameter passed from the accumulator to each of the presses, and the accumulator could be opened to either of the presses as required. All the valves for working this apparatus were under the control of one man in a valve-house on the top of the aqueduct. In working this lift, when one trough containing barges and water 5 ft. deep was at the top of the lift, the other, containing barges and water 4 ft. 6 in. deep, was in the river below. As the upper trough was heavier than the lower one, it followed that as soon as the valve on the 5-in. pipe was opened, the upper trough descended and lifted the lighter one out of the river, until, by becoming in its turn immersed in the river below, it lost part of its gravitation, and forced the lighter trough to within 4 ft. 6 in. of the top of the lift. The valve on the 5-in. pipe was now closed, and the remaining water in the press under the descending trough was allowed to run to waste into the aqueduct. The trough consequently descended into the river, and the barges it contained had been lowered from the canal to the river. Whilst this was going on the accumulator was opened to the press of the ascending trough, and this trough and barges were raised to within 6 in. of the top of the lift. The barges were lifted the remaining 6 in. by letting this depth of water into the trough from the aqueduct. Thus a depth of 6 in. of water over the area of the trough taken from the upper level was sufficient to lower one trough from the canal to the river, and at the same time, with a little assistance from the accumulator, to lift the other from the river to the canal. Automatic syphons insured a depth of 4 ft. 6 in. of water in an ascending trough. The edges of the gates were kept watertight with india-rubber, and the same material was used for making a joint between the troughs and the end of the aqueduct. The time required to lower one trough and to lift the other was three minutes, and the whole operation of transferring barges from the canal to the river and others at the same time from the river to the canal was eight minutes. In a chain of locks at Runcorn having the same fall a boat could only pass one way in one hour and a half. A very small staff was required to work the apparatus, and the total weekly expenses did not exceed £10. In addition to the time saved by this lift compared with a flight of locks having the same fall, it was stated that when the traffic was equal in each direction, only 6 in. of water over the area of the trough were used, instead of 50 ft. required by the locks.

The lift was publicly opened by the trustees in July, 1875, and had given great satisfaction. The iron-work and machinery were constructed by Messrs. Emerson, Murgatroyd & Co., of Stockport and Liverpool, and the foundations, masonry basins, etc., were carried out by Mr. J. W. Sandeman, M. Inst. C.E., the present engineer to the Weaver Trustees.

ELECTRO-MOTIVE ENGINES.

THE invention of Mr. E. Burgin, of Paris, consists of certain peculiar methods of constructing and arranging the elements or electro-magnets forming the generating cylinders of magneto-electric machines, and to the modes of lapping and connecting the several coils of such magnets, whereby currents of quantity or of tension are obtained. The same apparatus is applicable as an electro-motor when excited by a battery or magneto-electric machine.

NECESSITY FOR MORE SKILLED ARTISANS.

By JAMES M. BLANCHARD.

THE necessity for the acquirement of greater skill by the artisans of this country is a great and continually growing one, and all classes of people are, or should be, interested in having provision made for acquiring such skill. While it is true that we have many artisans whose attainments will compare favorably with persons standing at the head of similar occupations in other countries, and who are an honor to themselves and to the country, yet it is equally true that a large proportion of the class referred to are not in the possession of the requisite amount of skill to enable them to compete successfully with their more fortunate rivals. This condition in which they find themselves placed has grown out of two very popular but very grievous errors: First, the prevailing belief that any person of mediocre talent and acquirements who can not afford to educate himself for some profession, is quite fit for an artisan; and secondly, that any person having a fair endowment of natural abilities, but little or no education, is quite capable of becoming a successful mechanic.

It is these two prevailing opinions that have driven into the ranks of artisans so many persons who have not had the requisite training, and who, without fault upon their part, have flooded the market with unskilled labor. Before proceeding farther it may be well to define what is meant by, or what constitutes, skilled labor or a skilled artisan.

The answer to this is plain, and can be given in one word—training. But the requisite or proper training is of a duplex character; it is not enough that a person is skilled in the use of tools or the implements necessary to enable him to give form to whatever he may be engaged upon, he must also be trained to scientific methods of thinking and reasoning, so that when an idea is suggested the reasoning faculties may determine its correctness or error, in order that the hands may be relieved from the necessity of doing a large amount of unnecessary labor in determining facts which it is properly the province of the mind to do. It follows, then, that to enable a person to become a skilled artisan, he must first become a scientist to such an extent as to be able to understand fully the character and composition of the material which he may be called upon to manipulate, in order that he may be able to select the best for his purpose, and in order that he may logically and correctly determine the effects of the selection he may make.

As necessary as the education above hinted at is, a person may possess it all and yet be very far from being a skilled artisan. He must add to such acquirements a thorough practical knowledge of the art in which he proposes to engage, and hence the duplex training becomes an absolute necessity in the production of a skilled artisan.

Having shown the necessity for a thorough training of that portion of the people who propose to become artisans, it remains to point out how such training may be had and paid for in order that the poorest in worldly goods may avail themselves of the advantages it offers.

The writer is well aware that, as a rule, the class of people he is speaking of are not able to send their sons to the schools where they, by spending years of time, could acquire the theoretical part only of the training required; the services of such youth being an actual necessity to the support of the family, they must be put where they can be earners of money, and not spenders; but, were this otherwise, there are no schools within the reach of the poorer classes where both branches of the training referred to can be had; and as a consequence, a person desiring to fit himself for the greatest amount of usefulness as an artisan must first spend years in acquiring what is called an education, after which he must "learn a trade," a process which involves the expenditure of an unnecessary amount of time and money.

What seems to be required for the benefit of this class of persons is the establishment of one or more polytechnic schools, where both the theory and practice required can be had by allowing the student to divide his time between labor and study, a portion of each day being devoted to each, thus enabling him to acquire in five years what it would require eight to do under any of the present systems; added to which would be the great advantage of being in a position to compare theory with practice in case of there being a difference between them. The benefits derived from such schools and such training which would accrue to railroad companies, and to private employers of the people thus educated, would be incalculable, as it would enable them to provide their establishments with a class of men who are in possession of facts, and who would be able to determine at once what pretended improvements to adopt and what to reject; at the same time it would enable them to have the greatest amount of work done with the least possible outlay of money for shops and tools. Every observant employer knows that when he employs two mechanics for the same kind of work, even though they may be physically the equals each of the other, he does not get the same character or quantity of work from both, and the reason is that one is more skilful than the other, and it is probable that he is in advance of his fellow in this respect because he has been more methodical in his thought, and has subordinated his hands to his brains; and it is also probable that had both of these parties been trained in a school where one method of thought and action was presented for both, they would have been equals, and that the usefulness of both would have been enhanced as well as the profits of the employer.

The necessity of greater skill in our artisans having been shown, it remains to be shown how the facilities for acquiring it can be obtained.

The United States Patent Office is a bureau of our government, established ostensibly for the protection of the citizens who, by their superior knowledge or by the exercise of their inventive faculties, are able to produce any new and useful art, machine, manufacture, or composition of matter, or any improvement upon any art, machine, manufacture, or composition of matter, and shall under certain conditions have a patent therefor which shall, for a stipulated number of years, give them the exclusive right to make and sell the same. This bureau is by law self-sustaining; it is not and can not be any expense to the government, but the funds for its support are raised by a tax or charge made against each individual who applies for a patent, and it is out of the fund thus created that all the expenses of the office are paid. It should be stated here that the inventors are taxed upon whatever property they may own in all respects like other citizens, and that the tax for examining their inventions is an extra one, one to which no one else is subject.

Of the fund thus created there is now in the Treasury of the United States, to the credit of the Patent Office, nine hundred thousand dollars or more, which shows that the tax is more than is necessary for the maintenance of the bureau. It does not seem to admit of a doubt that the money alluded to as in the United States Treasury is in equity the property of the inventors of the country and of no one else; and it is believed that the most daring financier of the times would hesitate to say that it could equitably be appropriated for any purpose outside of one that would be directly in furtherance of their interests. Holding, as I do, that this fund must either be spent for the benefit of inventors or squandered in the interests of those who have no right to it, I venture to suggest that it be set aside for the establishment of such a school or schools as are herein proposed. It may be said that the amount is not enough to establish such a school and to sustain it when in operation; but to this view may be opposed the fact that it is at least more than sufficient to build all the necessary buildings for two or three such institutions, and to furnish them with all the appliances necessary for the prosecution of the studies of those placed therein, and that the interest upon the remainder, and the small amount of tuition-fees that could properly be charged, would furnish the funds to keep them in successful operation; and should this not be the case, Congress could make an appropriation therefor, without its being the most reprehensible act that it ever committed. The writer is aware that polytechnic schools in which many branches of art *or* science are taught are in existence in many countries, including our own; but they do not comprehend all that he conceives to be necessary to the proper training of artisans. They should be schools in which many branches of art *and* science are taught conjointly rather than where many branches of art *or* science are taught, in order that all the training which the most skilful artisan requires can be obtained. This, being our Centennial year, seems to be an appropriate time to move in this matter, and as it is presumed that many if not all of the inventors of the country who are still alive will be there, it is suggested that they meet in their respective towns, counties, or cities, and select delegates to a convention to be called by said delegates at some suitable period during the continuance of the Exposition at Philadelphia, to consider the propriety of petitioning Congress for an appropriation of the funds above alluded to, and for the purpose stated.

Before closing this article I desire to appeal to the inventors of this great country not to let this opportunity pass unimproved, it being as favorable a one as is likely to present itself for insisting that the money which is now on hand, that which has been taken from them, and all that may accrue from the same source in the future, shall be placed within their control in order that they may build to themselves a monument in the form of such a place of training for artisans as has been described, and that they may dedicate it to such uses for all time. Let us as one man join in asking this as our right, not as a subsidy for something to be done in the future, or as a reward for past favors, but as a right, which it clearly is, because it is a fund accumulated by a tax levied upon the few for their benefit and not for the benefit of the many; were it otherwise, it would be contrary to the spirit of the institution and the fundamental laws of the country.

I find that as early as March 3d, 1849, fifty thousand dollars was appropriated from the Patent Office fund for the erection of the building in which the office is located; and it is clear to me that the government ought to refund that amount and all others that have been thus appropriated, with interest upon the same up to the time when it is paid. I find that in the year 1838 the receipts of the Office were $4721.44 more than the expenses; in 1839 they were 2716.49, and they have increased gradually from that time to 1875, when they were $21,795.65; from which fact some idea can be gathered of the amount of interest that has accrued upon the amounts thus accumulated. Let me express the hope that editors to whose knowledge this proposition may come will in their own way bring it to the attention of their readers, in order that the parties interested may act upon the hints presented, if in their judgments it shall seem best.

Much more could with propriety be said upon this subject, but as it is only designed at the present time to direct attention to this subject, more need not be said except to inform any person interested that should any facts or figures be required in relation to this fund, the writer will cheerfully undertake to furnish them.

GOLD IN INDIA.

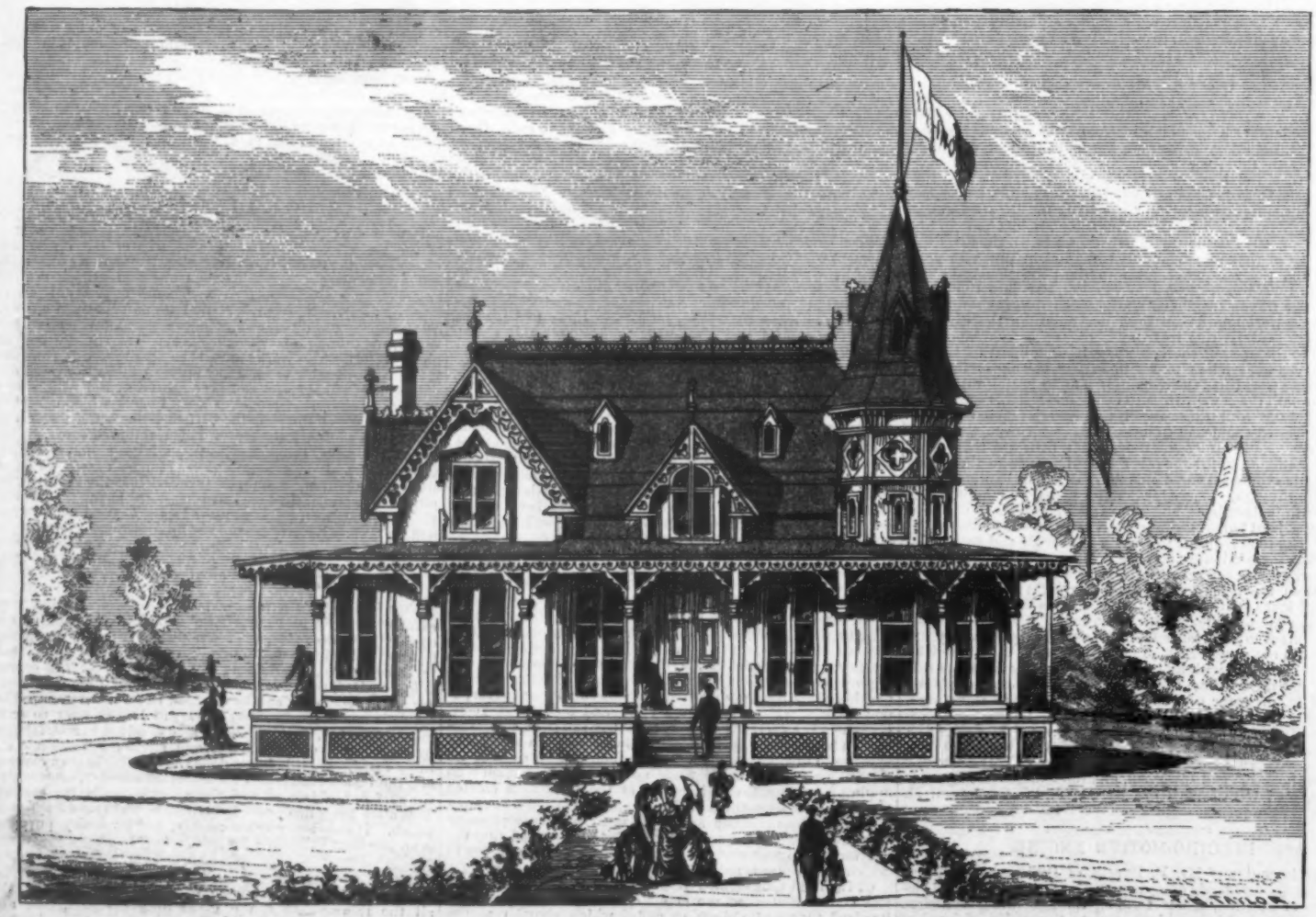
THE Madras newspapers have lately given some account of the Colar gold-fields, in Mysore, and of the operations which have just been commenced there by the Ooregum Gold-Mining Company. The auriferous quartz reefs are said to extend for a length of nearly twenty miles, and are only about twelve miles distant from a station on the Madras Railway. The company has already sunk one main and two auxiliary shafts, the former of which is expected to cut the reef at about 60 feet. The works have been so recently begun that it is not yet possible to form any accurate idea as to the probable results, but it seems to be thought that the field is one of great richness; moreover, it has a history which is said to go as far back as the year 1293, when Allageen, a general in the service of the Emperor of Delhi, returned from an invasion of Mysore, bringing with him a large amount of gold. Hyder Ali and Tippoo Sahib would also appear to have worked the mines. Should it turn out that the reefs can be profitably worked, the facts that they are situated at an elevation of 3800 feet, and that the climate is good, will doubtless tempt many Europeans to try their fortunes there.

NEW SUBSTITUTE FOR GOLD.

THE following is a new metallic alloy which is now very extensively used in France as a substitute for gold: Pure copper, 100 parts; zinc, or preferably tin, 17 parts; magnesia, 6 parts; sal-ammoniac, 3.6 parts; quicklime, 1.8 parts; tartar of commerce, 9 parts, and mixed as follows: The copper is first melted, then magnesia, sal-ammoniac, lime, and tartar are added separately and by degrees, in form of powder. The whole is next stirred briskly for about half an hour so as to mix thoroughly, after which the zinc is added in small grains by throwing it on the surface and stirring it until it is entirely fused. On this being done the crucible is then covered and the fusion maintained for about 35 minutes, after which the surface is skimmed and the alloy is ready for casting. This alloy has a fine grain, is malleable, and takes a splendid polish. It does not corrode readily, and for many purposes is an excellent substitute for gold.

LONDON, April 1.—In consequence of the dulness of trade, all the ironworkers of the great Sheepbridge, Atlas, and Cyclops Iron Works, in Sheffield, have been discharged. The employees of the Phœnix and Dronfield Bessemer-Steel Works have agreed to accept a considerable reduction instead of discharge.

THE INTERNATIONAL EXHIBITION OF 1876.—THE NEW-YORK STATE BUILDING.—(*See next page.*)



THE INTERNATIONAL EXHIBITION OF 1876.—THE ILLINOIS STATE BUILDING.—(*See next page.*)

NEW-YORK AND ILLINOIS BUILDINGS AT THE EXHIBITION.

(See illustrations on preceding page.)

IN continuance of our illustrations of the various special buildings that have been erected within the Exhibition, we give views of the New-York State and Illinois State buildings. Both are handsome structures, and worthily represent their respective sections of our great republic. These are head-quarters of the State Commissioners of the two mentioned States.

MONITOR-TURRET EXHIBIT.

AT the southeast angle of the Government Building a model of a monitor turret and pilot-house has been erected, which, by the use of wood and sheet-iron plates, is made to give a fair representation of the "Yankee cheese-box set on a plank" that did such good service during our late war. The interior is fitted up with slides, port-shutters, etc., and contains two fifteen-inch Dahlgren guns, mounted on strong gun-carriages.

THE TRANSCONTINENTAL HOTEL.

AMONG the numerous hotel enterprises intended for the accommodation of visitors at Philadelphia during the Exhibition is the Transcontinental Hotel, erected at the entrance to the grounds. It is owned by the proprietors of the well-known Continental Hotel of Philadelphia, which will be an assurance to many of excellence in all its departments. The building is the design of J. M. Wilson. It is built of brick, and has a frontage of 300 ft. on Elm avenue and 181 ft. on Belmont avenue. It is in four stories, besides the mansard roof, the height of the different stories being 14 ft., 12 ft., 10 ft., and 8 ft. respectively. It contains about 560 rooms, and is fitted up in the most perfect manner. The building is to be taken down in twelve months.

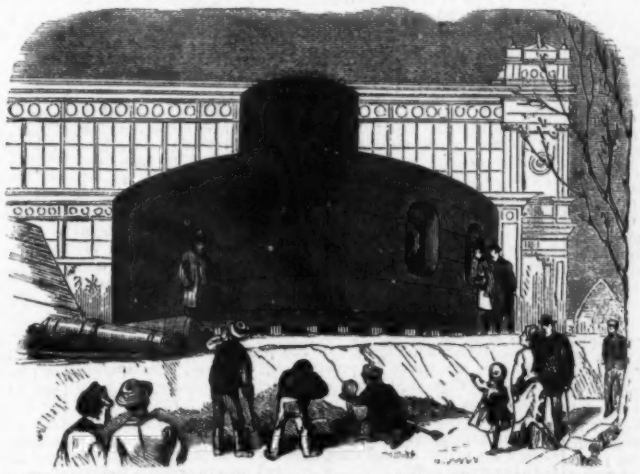
A GIGANTIC MINERAL SPECIMEN.

THE Kittanning Coal Company, of Philadelphia, exhibit the largest specimen of bituminous coal ever taken from the mines. There are two blocks, both taken from the Franklin Colliery, in Clearfield County. The smaller of these blocks weighs a little over two and one fourth tons, and the larger will balance at about five tons. These immense masses of coal have been taken out the full height of the measure, and one can scarcely conceive the immense amount of labor and ingenuity required to place them upon the cars ready for transmission. It was found impracticable to get the larger lump out on the truck, and it became necessary to improvise a flat-boat by which it could be dragged over the rails. The mass, having been first strongly secured with iron bands and strong oak plank, was gradually worked upon the boat or flat, and six heavy mules attached. Their united force was, however, unable to move the immense weight, and at last a block and tackle were procured, by which the coal was gradually drawn out from the mine. Many thousand eyes will gaze upon these specimens in admiration, without the most remote idea of the immense amount of labor required to remove them from their subterranean bed, but we have no doubt that they will be the means of proving the beauty and superiority of our coal deposits.

REMARKABLE MOSAIC.

ONE of the Italian exhibits, the gem of the collection—if indeed there be any distinction except in size, for there seems to be none in point of artistic merit—is the grand mosaic, "The Ruins of Pæstum." The *Evening Bulletin* says: "This most beautiful work of art is composed of upwards of 750,000 pieces or small cubes of enamel within a space of five feet eight inches by two feet two inches, and represents clouds, mountains and water, architecture, herbage, figures, trees and flowers, with all the science, light, shade, color, and perspective of a highly-finished oil painting. It required the use of more than 10,000 shades of primary colors, and years of labor to perfect it. Independent of its intrinsic merits, great beauty, and imperishable nature, it has interest and value as the sample of a curious and peculiar art, an art which Ghirlandalo used to say was the only painting for eternity.

"This picture is, however, peculiarly estimable for its design. Those magnificent ruins are the most venerable monuments of classic architecture in Italy, and the most striking existing 'records of the genius and taste which inspired the architects of Greece.' Readers of Eustace's celebrated work, 'Travels in Italy' and 'Notes on Naples,' need not be reminded of the enthusiasm with which the author refers to the venerable ruins of Pæstum. He does not hesitate to declare that in all the elements which go to make up the various phases of artistic grandeur and beauty 'there is nothing to equal these ruins on the wide earth.' And this is the subject which the artist has chosen and developed, in all its vast expanse of beauty, by the force of his genius.



INTERNATIONAL EXHIBITION OF 1876.—MODEL MONITOR-TURRET.

THE NEW SOUTH WALES EXHIBIT.

THE colony of New South Wales exhibits coal, gold, iron, antimony, copper, tin, kerosene-shale, and wool of fine quality and length of staple, which it is expected will find a demand in the United States, to mix with the shorter staple of our own production. The kerosene-shale produces a kerosene of brilliant illuminating quality. One can not ponder on the creditable display made by New South Wales without the suggestion occurring to the mind that the Philadelphia Exhibition is likely to be remarkable as displaying the energy, growth, and wonderful advance of the younger nations and colonies as compared to the older ones. "Victory," it is true, "always favors the big battalions;" but the big battalions of to-day are not those of to-morrow. The penal settlement of this age is a sturdy young nation of the next. Emigration, which is practically political desertion, destroys the calculations of diplomatists, parcels out the face of the earth to the confusion of our geographers, gives new material to the historian, effaces the distinctiveness of races by commingling them in such a manner that while the naturalist is considering the metamorphoses and extinction of the old, he is at an utter loss to conjecture the probable distinctive features of the new races. Hence he finds the practice almost invariably, so far as the human race is concerned, almost always in advance of the theory of his profession, and must be content to construct the latter from the former.

It is instructive to find a young colony like New South Wales with a balance of trade of about $5,000,000 per annum in her favor, the total population being but little over one half of that resident in, and not nearly one half of that doing business in, New-York City. It is quite as instructive to consider that so young a colony had in 1874 a total of 436 miles of railway, and that its production of metals up to 1874 were in value, in round numbers: gold, $152,661,230; tin, $4,332,305; copper, $4,037,380. That it had in 1874, 8000 miles of telegraph constructed, and that it exported wool to the value of about $25,000,000, and possessed in 1875, 22,872,882 sheep and nearly 3,000,000 horned cattle.

EAST-INDIAN EXHIBITS.

IN the glass cases of the East-Indian court there are exhibited, as the handiwork of native East-Indian ladies, nets embroidered with beetle-wings, gold cloth embroidered with beetle-wings, satin embroidered with gold thread, checker-boards gold embroidered, fine specimens of hand-made lace handkerchiefs, embroidered slippers of exquisite needlework by the ladies of Cashmere. The mineral collection embraces specimens of yellow, red and crude arsenic-corundum of fine quality from Madras, agates, rough garnets, ruby sand, carbuncles, and black mica. There are also small samples of unusually fine pottery clays. The agricultural display of this court includes excellent samples of teas and coffees, and the attention of the visitor is immediately directed to the temperate climate of the hill regions by the fine display of cereals, comprising many varieties of wheat, oats, and barley, all large in the grain. There are 40 distinct varieties of peas, each distinct in size and shape, their colors varying from almost black up through the shades of red to yellow. Of beans there are 65 distinctive varieties. Forty other kinds of cereals are classified under the head of grains, while there are in addition the following grains or cereals which are articles of diet in the Indies: 23 varieties of millet, 15 of Sanwa, and 20 of Raggee seeds. Of unhusked rice, which is called *Paddy*, there are the following varieties: From Bombay, 20; Bengal, 25; Burmah, 20; Cashmere, 3; Oude, 2; and Punjaub, 5, there being a like number of samples of dressed or cleaned rice from each place. Beneath a large glass case there is already in position a specimen of stone sculpture which formed part of a Buddhist Tope at Amaravati, the figures, which are in bas-relief, being allegorical of tree and serpent worship. Among the other works of art are a Kooftgari casket made of gold, very finely inlaid with other metals, a box and covering of Bidrieware, and boxes of white marble inlaid with flowers and vines composed of colored marbles.

THE INTERNATIONAL EXHIBITION OF 1876.—THE TRANSCONTINENTAL HOTEL.

UNHEALTHY TRADES.

A LECTURE BEFORE THE SOCIETY OF ARTS, LONDON, BY DR. B. W. RICHARDSON.

(Continued from page 279.)

Sulphurous Acid Gas.

WHILE speaking of this compound of sulphur and oxygen, sulphurous acid, I may mention, incidentally, some curious facts bearing on the effects of sulphur. In the great vine-producing district of the Herault, sulphur is employed to destroy the minute fungus called the oidium. The oidium is injurious to the vine, upon the stem and leaves of which it fixes, and sulphur is dispersed over the leaves of the vine, either with a fine sieve or with bellows which are made to blow it over, in order to destroy the parasite. The effect of this process is to induce in the workpeople who are employed in this task an ophthalmia, or inflammation of the eyes. The pain, redness, and swelling of the eyes is most distinct and distressing in the middle of the day, when the heat and solar radiation is most intense. Women and children are the severest sufferers. We are indebted to M. Bouisson, of Montpellier, for the first description of this induced disease.

One or two other singular points deserve a passing notice in connection with this subject, the oidium and disease. The oidium itself has been assigned as a cause of disease. M. Collin reported to the Academy of Medicine, in the year 1864 that three persons who were cutting vines, by an accident cut themselves, and were poisoned by the oidium. They all suffered after a few days from loss of appetite, shivering, and fever. Their wounds, which originally were slight, became gangrenous, and their limbs swollen. In all of them there was *muguet* of the mouth, which consists of a cryptamous product called the "oidium" of the mouth. From this circumstance it has been inferred that the parasite cryptogamic oidium may become by inoculation a cause of disease in the human subject. This theory was not a little strengthened by a discovery made in May, 1858, by Professor Laycock, the distinguished professor of medicine in the University of Edinburgh, of the *oidium albicans* in the pellicle of false membrane that had formed in the throat in a case of diphtheria.

Lastly, it deserves note that a similar parasite fungus—*oidium aurantiacum*—was discovered by the late Dr. Robert Dundas Thomson in a specimen of bread made from that inferior kind of flower which so easily becomes acid when it is exposed to moisture, and which emits the well-known sour smell, even after it has been turned into bread, if it be for a short time exposed to moist air. It has been inferred that disease may be taken from the use of a bad flour containing the parasite. The evidence on this point is as yet entirely speculative, and I am diverging from the subject proper of my lecture in referring to it. It opens an interesting side view into causes of diseases. We must return now to the natural causes of inquiry we are pursuing, adding, on our own way, the disease *ophthalmia* to the list of industrial pathology.

Sulphuretted Hydrogen.

In some occupations, as in certain of the chemical manufactories, the operatives are exposed, at times, to the action of sulphuretted hydrogen gas. This gas is evolved in certain processes of chemical decomposition, and it is also evolved in some forms of organic decomposition, as, for example, in the organic decomposition of sewers and cesspools. The gas is an active poison, and death is an occasional result of its inhalation. Its action on living functions has been very carefully studied by myself, by the late Dr. Herbert Barker, of Bedford, and by other observers. The gas diffused in breathing air in the proportion of 1.714 per cent is immediately fatal; and in the proportion of 0.205 per cent it produces quick insensibility, with feebleness of respiration and muscular tremors. Even when diffused in the much more minute proportion of 0.056 per cent—in which solution it is after a time indefinable by the sense of smell—it produces, when inhaled for a short time, diarrhœa, rapid pulse, heat of the surface of the body succeeded by coldness, and after-symptoms of low continued fever.

These are the physiological effects of sulphuretted hydrogen, as they have been experimentally determined; but I have been unable to discover whether they are definitely traceable in the human subject amongst those who are employed where this gas is liberated. In sewer air the gas is present, and the concentrated air from the cesspool, in which the gas is also present, has been found, experimentally, to produce, when it is inhaled, symptoms like to those which are caused by the gas itself. I have inquired carefully whether amongst men working in sewers the symptoms observed in experimental research are specially manifested, but have been able to arrive at no certain affirmative result. The same applies to manufactory work where the gas is used, and I suspect it only becomes injurious when, by accident, it is breathed in such large quantities as to prove rapidly fatal.

When it kills in this direct way it induces a form of *apoplectic coma*, and under this name we may characterize the industrial accident of disease which occurs from its presence in large quantity

Chlorine.

The vapor of chlorine is another gas used in bleaching, and in some other industrial processes. The vapor, when inhaled by the workmen, is productive of suffocating cough and temporary embarrassment of breathing, with headache, and at first nausea. It is remarkable that chlorine, when it is being inhaled, does not produce more decided constitutional effects. The workmen affirm that they become accustomed to it, and after a time it ceases to cause them any pain or anxiety.

Ammonia Gas.

In many occupations ammonia is liberated in free quantities. In the process of hat-making shellac is dissolved in a weak solution of ammonia. The felt is then steeped in the solution, and the ammonia, volatilized by heat, charges the atmosphere with its vapor. In other occupations ammonia is liberated in the decomposition of ammoniacal salts. In a third class ammonia is given off from decomposing organic compounds. In all cases the workers are exposed to the ammoniacal gas.

Considerable difference of opinion exists on the question of the harm that is inflicted by the inhalation of ammonia. Some observers have arrived at the conclusion that the gas inflicts no injury, and I am of opinion that the injury is much less than might at first sight be supposed. When, however, the inhalation of ammonia is long continued, certain physical effects result which must be considered injurious. The blood is rendered unduly fluid, the corpuscles of the blood are changed in form, and are made crenate, the oxidation of the blood is reduced, and the disease anæmia, which has already been designated, is developed.

There are some occupations in which decomposing organic remains are present, and which yield to the air of the place where the labor is carried on an ammoniacal-sulphur odor which is most offensive, and which even taints the clothes and person of the worker. Those who are engaged in the labor of making catgut strings and cords, those who are engaged in dressing skins into rugs, etc., fellmongers, and those who act as bone-sorters and boilers are specially subject to these odors. A woman who was engaged in the first of these occupations, and who came to a public dispensary, to which I was physician, for medical advice, was so offensive she could not be tolerated in the waiting-room with the other out-door patients, and she had to come in after all the rest had gone. The odor from the fellmonger's yard and from the bone-boiler's premises, is detectable even at long distances from the place. It would be assumed, at first thought, that the operatives, breathing for many hours every day such an atmosphere, must needs suffer from some marked disease. I am bound to say that the evidence in support of this suspicion is all but negative. I have been unable to discover any definite symptom of disease connected with these callings as the result of the labor. Neither can I find any statistical facts that illustrate an unusual mortality from such labor.

EFFECTS OF VAPORS.

Vapor of Turpentine.

We are indebted to M. Marchal de Calvi for the first intimation that the vapor of turpentine produces a specific effect on those who are engaged in painting in oil and lead colors. Before his time it was considered that the lead in paint was the cause of disease. De Calvi proved that, when the lead is fixed, the emanations from the painted surface, which consist purely of turpentine, are exceedingly poisonous. He further pointed out that some workmen are what is called idiosyncratically affected, in other words, that certain workmen are specially affected, but that all are liable to suffer. My own observations, made at various times since Calvi's announcement to the Academy of Sciences in Paris, on December 9th, 1855, fully confirm his discovery. Turpentine vapor produces, I find, very marked symptoms of disease in workmen, especially when they are engaged in the process of flatting. The symptoms are those of prostration, coldness, constipation, giddiness, disturbed nervous function, intense headache which lasts for many hours, impairment of appetite, and anæmia. These symptoms are produced from the use of turpentine varnishes, as well as from paints. Some workmen escape the action almost altogether; others are so susceptible that they will rather pay more favored men to perform the job than do it themselves.

The mode of action of turpentine on the body is not yet fully understood. When it is rapidly inhaled as a vapor it produces sleep, like chloroform, and it has been used in an emergency as a substitute for chloroform in order to bring on anæsthesia. A key to its action was given some years ago by Dr. L. C. Roche, who, in commenting upon the researches of Marchal de Calvi, relates an interesting fact told to him by the illustrious chemist Thenard. It is that Thenard analyzed the atmospheric air of a cellar which had become poisonously charged with the vapor of turpentine, and found that all the oxygen had been removed, so that nitrogen alone remained. Hence Roche assumes that turpentine produces its bad effects by depriving the air of oxygen. I believe this theory to be sound, but it does not explain all the facts. A more recent research by Dr. Liernsh has proved, by direct experiment, that turpentine vapor causes paralysis of the vessels of the minute circulation, and congestion of the brain and of the other large vascular organs.

Constipation and *temporary congestion of the brain* are thus added to the industrial diseases by this agency.

Bisulphide of Carbon.

Of late years the volatile fluid, known originally as the alcohol of sulphur, then as sulphuret of carbon, and now as bisulphide of carbon, has come into great use in various industrial pursuits. It is employed for taking grease out of wool; for extraction and purification of paraffin; for extraction of oil from oil-cakes when pressure is of no further use; for draining the sawdust used in refining oil by filtration; for extracting grease from bones or kitchen refuse; and for extracting aromatic essence and perfumes from plants. But the most important use of this body, perhaps, is in the manufacture of inflated caoutchouc articles, balloons, and waterproofings. In the first the bisulphide is largely used, temporarily to dissolve the caoutchouc, and bring it into such a state of softness as will allow it to yield to the blast of air from the bellows. In the second, it is used for varnishing with india-rubber. The peculiarity of the bisulphide of carbon is, that on its volatilization the substance dissolved in it is deposited, while itself diffuses through the atmosphere.

The effects of this vapor on the workmen were first described by M. Delpech to the Academy of Medicine of Paris, on January 15th, 1856. The effects are peculiarly severe. They consist, first, of symptoms of anæsthesia, with intoxication. Afterwards they become more chronic, but the head is much affected at all times, and partial insanity is not infrequent. The taste is vitiated; the sight and hearing are troubled; the digestion is perverted so that the appetite is increased, even to gluttony, and there is persistent nausea. The breathing organs, the organs of the circulation, and all the secreting organs are deranged, and such enfeeblement results that the workers, so long as they continue at their work, are simply wretched.

No name can be found for this particular disease from the old classification of diseases; that which it induces is a malady, *sui generis*, from which the victim suffers so long as he labors. The symptoms include derangement of mind as well as body. The disease approaches most nearly the general paralysis of the insane, and we may classify it as *cerebral paralysis*.

Vapor of Nitric Acid.

The vapor of nitric acid is a source of injury in some occupations. It is experienced mostly in the process of fur-dyeing. The acid is used in this process for two purposes: for freeing the substance of the fur of greasy matter, and for giving a dark yellow or brown stain. The vapor of the acid rises very freely, and is of necessity inhaled by the workmen. The symptoms produced are dryness and redness of the throat, constant constipation, and severe pain at the back of the head.

Now and then in the practice of the chemical laboratory the inhalation of the vapor of nitric acid produces very serious effects. A man who was engaged in my own laboratory once suffered severely from this cause, the symptoms of difficult breathing and cough lasting for several days. In March, 1863, Mr. Steward, a master in the school of the Edinburgh Royal Institution, and one of the janitors of the school, died from this cause. A bottle of acid was accidentally spilled, and the two men inhaled the vapor. Neither of them at the time felt pain; but both died, one ten, the other thirty, hours after the accident.

Vapor of Hydrochloric Acid.

In some chemical factories the vapor of hydrochloric acid produces injurious effects, and, to a certain extent, the action of the vapor is felt by men who use this acid—for which the name of spirits of salts is still maintained—for soldering and other mechanical purposes. The symptoms produced are dryness of the mucous membrane of the nose, mouth, and throat, with suffocative cough, and sometimes spasmodic difficulty of breathing. To remedy this evil in chemical work, M. Kuhlman, of Amiens, at his large manufactories of artificial soda, invented and completed a most efficient apparatus, by which the fumes of the acid were condensed into a salt of barium, by making them pass through a fine rain solution of carbonate of baryta.

Altogether these three last-named gases or vapors, although they are capable of destroying life accidentally, are not so serious a cause of chronic disease as some other agents with which we have become familiar. Such symptoms of a chronic kind as are induced by them may be classified under the heads of *constipation, bronchial irritation, nausea, and headache.*

(To be continued.)

ON THE PREPARATION OF DEXTRINE-MALTOSE (MALT SUGAR) AND ITS USE IN BREWING.

BY WM. GEO. VALENTINE, F.C.S.,
Royal College of Chemistry, South Kensington.

[A paper read before the Chemical Section of the Society of Arts, London, March 15th, 1876, Prof. Williamson, F.R.S., in the Chair.]

I HAVE been asked to bring before the Chemical Section some recent observations and improvements made by myself and my friend, Mr. Cornelius O' Sullivan, who, since leaving the College of Chemistry, and after having spent some time with Dr. Hofmann in Berlin, has been in the employment of Messrs. Bass & Co.

I should have preferred if Mr. O'Sullivan had been able to spare the time to give the Society the benefit of his vast stores of practical and scientific knowledge of the art of brewing, and I should certainly have hesitated to undertake the task of delivering a lecture before the Chemical Section, which comprises so many brewers of great practical and theoretical acquirements, if your secretary had not allowed me to confine myself to the limited subject indicated by the title to this lecture, namely, the "Preparation of Dextrine-Maltose (or Malt-Sugar) and its Use in Brewing," to the production of which, on a manufacturing scale, I have of late given much time and attention.

The art of preparing fermented liquors, dating as it does from the remotest times, and met with among various races widely separated from each other, was up to very recent times of a purely empirical character. It is only during the last thirty or forty years that the progress of chemical science left its mark upon this art, as upon so many others. Our greatest brewers, among whom I would, without fear of encountering the reproach of flattery, single out the great brewing firms of Messrs. Bass & Co., and of Messrs. Allsopp & Sons, availed themselves speedily of the conquests made by pure science which promised to throw light upon their purely empirical processes, and to clear away the mist that hung over some of the chemical changes involved in brewing. Thus it has come to pass that, from the heads of these firms down to the under-brewers, a chemical knowledge was considered the requisite thing, and that we see eminent scientific chemists now superintending the chemical departments of these firms. The progress made in the chemistry of brewing, although at present locked up to a great extent and rendered unavailable to the general public, has been very great. The labors of Pasteur and other scientific investigators have been eagerly examined and applied practically by brewers; and, by following up Pasteur's microscopic researches on ferments, we are promised that by a careful microscopic examination of the yeast or barm, we may keep disease out of the brewing-house, or arrest its propagation with freshly-brewed beers. It will in like manner be possible to predict whether such beers contain any ferments which will damage or destroy their keeping powers—that is, whether they carry in themselves the germs of inevitable destruction immediately after brewing.

Considering the great help which pure chemistry at various times has generously rendered to brewers, it may well be thought desirable, in the words of Mr. Robert Warrington, F.C.S., who favored the Chemical Society recently with his great stores of knowledge gained in the manufacture of tartaric and citric acids, in Mr. Lawes' Millwall Laboratory, "that most of the large amount of information which is acquired in the laboratories of our great manufacturing concerns might be published without any injury to the individual manufacturer."

The chemical reactions involved in the manufacture of beer are not very numerous, and are still rather imperfectly understood. The process may be said to have for its object the production of a partially fermented and gradually fermenting liquid, termed beer, from barley, hops, water, and yeast.

In the preparation of wine, the grapes have only to be pressed to obtain the saccharine liquid which by its fermentation yields wine. The saccharine matter—the grape-sugar—is ready formed. But when wine of barley, or beer, has to be made, nature has not elaborated so much of the process. She gives us the raw material in a different form: the alcohol producing portion of the grain is starch chiefly. It is the object of the maltster and brewer so to act on the grain as to produce beer.

Alcohol results from the vinous fermentation or conversion of grape sugar or glucose into alcohol and carbonic acid, according to the equation,

$$\underbrace{C_6 H_{12} O_6}_{\text{Grape Sugar.}} = \underbrace{2\ C_2 H_5 Ho}_{\text{Alcohol.}} + \underbrace{2\ CO_2}_{\text{Carbonic Acid.}}$$

In grapes this sugar results, no doubt, from the slow action of the soluble albuminoid substances contained therein during the ripening process. The wine which is made from grapes constitutes a more or less completely fermented alcoholic liquid, derived mainly from the grape-sugar, which differs from beer in being a completely fermented liquor, practically without any dextrine, and, with the exception of artificial effervescing wines, such as Champagne, sparkling Moselle, &c., also without carbonic acid.

The process of wine-making has, as is well known, undergone considerable changes, especially during the last 10 or 15 years, since chemistry has thrown light upon the changes involved in it. A considerable quantity of good wine is now made by repeated fermentation of the squeezed skins or husks of the grape with some artificially prepared grape-sugar. This is known under the name of "Petiot's" process. According to another process called, after its originator, "Chaptal,"

sugar is added with most excellent results, in unfavorable wine years, as a corrective for the increased amount of acid.

Gall proposed to dilute acid wine with water, to the proportions found in wines of good years, and to add the requisite quantity of sugar, to produce the proportions of alcohol and acid, contained in wines made during good wine years.

There can be no doubt that all these processes are perfectly legitimate, and, if practised with the proper knowledge and care, can only be beneficial both to the wine-grower and consumer.

Cane-sugar or loaf-sugar is mostly used for such purpose, on account of its greater purity and freedom from non-fermentable constituents as well as albuminoid substances. Its composition differs from that of grape-sugar, $C_6 H_{12} O_6$, by containing less water, namely, $C_{12} H_{22} O_{11}$, and during the fermentation it has to be converted into the glucose called grape-sugar, by the assimilation of water; 86.4 parts of cane-sugar perform, therefore, the same amount of work as 100 parts of pure crystallized grape-sugar.

The stages through which the starch in barley—the grain which is almost exclusively used in this country—passes before it reaches us as the fermented alcoholic extract, called beer, are more numerous, and probably of more complicated nature. They may be considered in the following order:—

(1) Malting.
(2) Mashing.
(3) The fermentation of the wort.

In order to show a *raison d'être* for bringing before you the new substitute for malt, which we have termed "Dextrine-Maltose," or malt-sugar, I shall first dwell upon the composition of malt, and will endeavor to show you that, by a patient study of the constituents contained in malt before and after infusion, in connection with those contained in the fermented beer, much additional insight into the brewing process may be gained.

COMPOSITION OF MALT.

Chemists gain their knowledge of the composition of matter by certain analytical processes: that knowledge is the more perfect, the more perfect and reliable the analytical processes are which they have to employ. Now we possess pretty accurate methods for the quantitative estimation of moisture, ash, fat, cellular matter, and total albuminoid or nitrogenous matter; but little or no attention has hitherto been paid to the different varieties of albuminoid bodies contained in malt. The isolation and estimation of the starchy matter, or, as I would call it by preference, of the carbohydrates which, without doubt, form the most important constituents of malt, is more difficult, and great errors have been made, as we have to rely mostly upon chemical methods which are likely to mislead if not carefully checked by other observations, if possible by polariscopic experiments. I give it upon the authority of Mr. O'Sullivan, that of the many analyses of malt which have been published, not one can be relied on in this particular respect.

Thus it has always been stated, even by more recent careful inquirers, such as Oudemans, that malt contains dextrine (8 per cent). O'Sullivan can not find any dextrine, although he looked most carefully for it by processes which would have yielded it if it had been present in malt. This opinion seems to be shared by other recent investigators, for example, by Kühnemann*, although the proofs which he adduces are meagre, and do not appear to be sufficient to warrant the conclusions at which he arrives.

Again, the amount of sugar (the variety is never stated) is usually set down at from .4 to 1 per cent. This too, O'Sullivan considers absolutely wrong. He finds in malt from 16 to 20 per cent of a fermentable sugar.

About half of this is due to the transformation of starch, or a carbohydrate of a like character, during the malting process. The remainder is ready-formed in barley, and differs from the one produced by malting. O'Sullivan has not yet been able quite satisfactorily to isolate and determine the character of these sugars, but of their existence he is quite convinced.

There is in the starch of barley a carbohydrate of the starch type having a laevo-rotatory action on polarized light. Kühnemann calls this body "Sinistrin," but from its general character, O'Sullivan is inclined to think the body is "Inulin." These remarks may appear to some of you, perhaps, premature, and not sufficiently supported by analytical facts. I had, however, to refer to them in order to render comprehensible the subjoined analyses of malts, which may be taken as typical for most pale malts, although the percentages of albuminoids and soluble carbohydrates are capable, to some extent, of modification by changes in the malting process.

The following table gives the detailed composition of two samples of pale malt:

	Malt No. 1.		Malt No. 2.
Starch	44.15		45.13
Other carbohydrates (of which 60 per cent to 70 per cent consist of fermentable sugars) Inulin(?) and a small quantity of other bodies soluble in cold water	21.23		19.39
Cellular matter	11.57		10.09
Fat	1.65		1.96
Albuminoids			
(*a*) Soluble in alcohol of sp. gr., .820 and in cold water	.63	.46	
(*b*) Soluble in cold water and at 68° C.	3.23	3.12	
(*c*) Insoluble in cold water, but soluble at 68° to 70° C.	2.37	1.36	
(*d*) Insoluble at 68° to 70°C., but soluble in cold water (albumin proper)	.48	0.37	
(*e*) Insoluble in cold water and at 70°C.	6.38	8.49	
	13.09		13.80
Ash	2.60		1.92
Water	5.83		7.47
	100.12		99.76

* Ber. d. Chem. Ges. Berlin, viii. 202 and 287.

Every item in these analyses has been estimated directly, and not by difference. The further elucidation of the carbohydrates, other than ordinary starch, O'Sullivan reserves, should time allow him, for a communication to the Chemical Society.

I have on another diagram given, for comparison's sake, an analysis of the Dutch chemist, Oudeman's, hitherto looked upon as among the most reliable analyses of barley and malt.

Table showing composition of barley and malt (Oudeman's):

	Barley, air-dried.	Malt, air-dried.
Dextrine	5.6	8.0
Starch	67.0	58.1
Sugar	none	.5
Cellulose	9.6	14.4
Albuminoids	12.1	13.6
Fat	2.6	2.2
Ash	3.1	3.2
	100.0	100.0

Albuminoid compounds in malt (Oudeman's):

(*a*) Soluble in alcohol	.34
(*b*) Coagulable by heat	.45
(*c*) Not coagulable	2.08
(*d*) Insoluble albumin	6.23
	9.10

By starting thus with a more clearly defined knowledge of the starch present in malt, we shall have less difficulty in tracing the changes which it undergoes during its conversion into beer, and you will be able to judge whether the substitute for it, which we can produce on a manufacturing scale, and which we have called, not by some fanciful name, but by a name which expresses its proper chemical composition, namely, Dextrine-Maltose, will deserve your serious attention.

(To be continued.)

FRENCH ACADEMY OF SCIENCES—MARCH.

On the Storms termed "Foehn" in Switzerland.—M. Faye calls the attention of the Academy to a curious meteorological phenomenon peculiar to the Alpine regions of Switzerland. When a cyclone coming from the south-east meets the Alps, it very often produces over a clearly defined region in Switzerland, and not elsewhere, conditions altogether different from those ordinarily caused by cyclones. Instead of being accompanied by a sensible lowering of temperature, the "*foehn*" brings increased heat and dryness: the temperature rises suddenly several degrees, and the air, at first saturated with moisture, becomes no less suddenly extremely dry. M. Faye considers that this phenomenon can be produced only by the gyratory descent of a considerable mass of air totally or in great part deprived of the cirri which the whirlwinds formed in the superior currents ordinarily collect and draw down. Then this air becomes heated in descending from the high regions, and its degree of humidity lowers beyond the extreme point reached in temperate countries. On the other hand, where the descending air draws with it vesicular water, and especially ice crystals, the heat developed by compression hardly suffices to vaporize the water or melt the ice, and the air reaches the earth at a temperature relatively low, and at a degree of complete saturation.

On a New Apparatus for Determining the Intensity and Law of Development of Pressure in Bores of Fire-arms, with relation to Time, by General A. Morin.—MM. Reffye and Pothier have heretofore arranged a cylinder of lead in a tube containing a piston, said tube being screwed into the bore of the gun. Under the pressure of the gas, the lead was forced to flow in a suitably disposed canal, and results were obtained leading to the hope that the process would allow of more accurate determinations of the tension of the gas than the apparatus hitherto employed. But the softness of the lead and the facility with which it flows under moderate pressure limit the tension of which it may furnish a measure, and it can not be employed for determining those developed under the action of heavy charges of powder. Tin, however, appears to satisfy all conditions. The jets obtained increase in length proportionately to the pressures, with a regularity quite sufficient for all desired applications.

Denoting by P the pressure in kilogrammes exercised per square centimeter on the base of the tin cylinder or the interior of the bore, by L, the length of the jet expressed in millimeters, it is found that $P = 237\ L$. By this simple apparatus, therefore, the direct measure of the maximum pressures developed by the gas may be obtained with a precision superior to that heretofore obtained, since each millimeter (.039 inch) of length of the conical jet will correspond to nearly 237 kilogrammes pressure per square centimeter, or 3258.7 lbs. per square inch. It is further proposed to prolong the conical case of the eprouvette which receives the tin cylinder, by a small cylindrical canal in which a stem shall be placed to be driven ahead by the flowing of the cylinder which it touches. To this stem is attached a pointer which traces a line on a chronometric apparatus. The length of the jets thus registered furnish the measure of pressures, and at the same time the intensity of the efforts and the precise instant when which was exercised, also given by the line, allow of deducing the laws of their development. By this simple addition of an indicating stem connected with very small chronometric apparatus, since the length of the jets will not exceed some fractions of an inch, a means is afforded of studying the rapid and complex effects due to the inflammation and combustion of various powders.

On the Influence of Temperature on Magnetization.—M. J. M. Gaugan offers the following complete *résumé* of his investigations on the above subject:

1. If a bar of steel is placed in contact with the pole of a magnet, and if for a point M of said bar the value of the current of demagnetization at ordinary temperature be determined, and if thereafter the bar be lightly heated by an alcohol-lamp, it will be found that the current of demagnetization corresponding to the point is (very probably) augmented.

2. When the bar is allowed to cool in contact with the magnet, the magnetization does not retrograde, but even becomes slightly strengthened.

3. When the bar has returned to the ordinary temperature, it suffices to remove it from the magnet for a few moments to cause the disappearance of a portion of the augmented magnetization resulting from the heating. When the contact is re-established between the magnet and the bar, the same total magnetization as before the rupture of the contact is not found.

4. When, instead of heating the bar of steel in contact with the magnet very moderately, the temperature is gradually elevated until the bar attains a blue color, it is found that the magnetization first increases, attains a maximum, and then retrogrades.

5. When the bar, after being highly heated, remains in contact with the magnet during the period of cooling, the total magnetization augments in degree as the bar cools, and when the surrounding temperature is reached, it retains a value much above that which it had before the heating of the bar. In a series of experiments made by the author, the value of total magnetization after heating was represented by 63.2, while previous thereto it was represented by 41.6.

6. We have seen (4) that when the temperature of the bar exceeds a certain limit, its total magnetization, instead of increasing, diminishes. From this it might be believed that the magnetization of the bar, brought back to ordinary temperature, equally diminishes when the temperature to which the bar is carried is elevated above the limit referred to above. This, however, is not the case. The total magnetization of the bar, returned to ordinary temperature, is as much greater as the bar has been more highly heated, as much less as said degree of heating falls below the temperature which imparts to steel a blue color.

7. When the bar regains ordinary temperature, it suffices to break for a few seconds its contact with the magnet in order to cause it to lose a portion of the increase of magnetization which results from heating—but it can be made to lose only a portion. Even after an interruption of the contact, the total magnetization is greater than before the heating.

If it be admitted that the magnetizing force exercised by the current of a coil on a steel bar diminishes when the temperature of the bar exceeds a certain limit, it must also be admitted that reciprocally the inductive action exercised by the bar on the closed circuit of the coil which surrounds it should equally diminish when the temperature exceeds the same limit.

On the Electric Conductibility of Pyrites.—M. Dufet's conclusions are that the conductibility of pyrites is a true metallic conductibility, very variable with the physical structure of the specimen, but which in a given crystal depends neither on the direction, nor the intensity, nor the duration of the current.

THE DIVISION OF POISONS.

By WALTER E. BIBBY, Ph.G.

As a large number of the medicines prescribed by physicians of the present day are very poisonous, it devolves upon the pharmacist to exercise the greatest care and caution in compounding prescriptions containing such poisonous substances as strychnia, hydrarg. chlor. cor., arsenious acid, narcotic extracts, etc. It often occurs that physicians prescribe these remedies in minute doses for children, aged persons, and delicate females; it is, therefore, exceedingly important that they should not receive a fraction over the quantity prescribed.

The greatest care and attention should be given to this class of prescriptions, so that, when a third is prescribed, a half grain may not be given, which, in all probability, would result very seriously, or produce a condition of affairs entirely different from that anticipated by the physician; moreover, the uncertainty attending the weighing of fractions of grains by ordinary scales, renders it necessary for the pharmacist to first weigh one grain and then divide this into the quantity prescribed; in other words, virtually guess at the quantity.

To remedy this, and at the same time secure to physicians and pharmacists absolute certainty, I would recommend the trituration of the poisons in common use be made of such a strength that each grain of the trituration shall represent a certain quantity of the poison, and the trituration be made only with sugar of milk. The reasons for using this substance are various. In the first place, sugar of milk is a harmless, hard, gritty, odorless and almost tasteless substance. It is less liable to attract moisture from the atmosphere than any other substance; in fact, it possesses all the qualities desired for making a perfect trituration. The proportions I would suggest are one grain of the poisonous substance to seven grains of sugar of milk, making in all eight grains, the whole to be thoroughly triturated. The process of trituration is too well known to pharmacists to require elucidation in this article, and they are also well aware how important it is to carry out this process in an exact and careful manner.

Now when a physician writes for a quarter of a grain of arsenious acid, all that is necessary is to weigh two grains of the trituration, and you have the quarter of a grain desired. This method I hold to be the safest in weighing poisons—a method by which very small fractions of grains may be obtained—and where children, the aged, or very delicate are interested, to be one of precision. The physician can also prescribe with a feeling of certainty when using those poisonous substances in this trituration, and he may have the assurance that, when he prescribes the one quarter of a grain, he obtains that amount; for the reason that two grains of any substance will turn the beam of an ordinary scale more readily than a quarter of a grain. I have seen scales in some of our first-class stores on which the half of a grain could not be weighed with any degree of certainty, but on which two or four grains could be weighed with accuracy.

Likewise, the pharmacist can be more expeditious in dispensing his order, thereby rendering the sick a prompt, safe, and reliable prescription, and one exactly in accordance with the physician's wants.

HYDROPHOBIA.

DR. O. DE STEFANO relates, in the *Gazetta Italiana*, three instances of persons bitten by the same rabid dog. The first case was that of Napolitano Rosa, aged 60 years. The dog bit him severely on the back of the hand. De Stefano was in the drug-store where the bitten man at once applied for relief. De Stefano immediately had recourse to pledgets of lint dipped in liquid ammonia, having first washed the wound thoroughly. When they became dry, other pledgets, similarly moistened with liquid ammonia, were substituted for the first. In ten days the wound was quite healed. The second case was that of Antonio Capiraso, about ten years old, bitten by the same dog in the left leg. Dr. De Stefano treated the boy precisely as he had treated the man, and with a like result.

The third case was that of Teresa, aged 60 years, bitten by the same rabid animal. The poor woman, unaware of her great peril, sought for no treatment, and consequently received none. After the lapse of six months, symptoms, as well marked as possible, of hydrophobia appeared, and the patient died. These cases certainly appear deserving of the utmost attention.—*The Doctor.*

[Engineering and Mining Journal.]

ON THE COMPRESSION OF GASES.*

By CHARLES F. BRUSH, M.E., of Cleveland, O.

THE compression of gases to a very high degree, for purposes of scientific research, has long presented serious difficulties to the physicist.

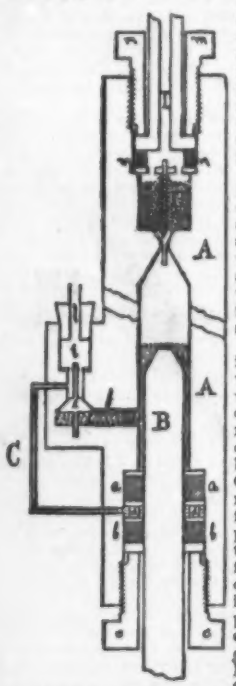
Great advances have been made of late years in the construction of ordinary air or exhaust pumps, while very little has been done towards the improvement of compression-pumps. The principal difficulties encountered in the construction of such apparatus are the existence of the so-called "dead space" in the pump-barrels, leakage of the piston-packings under high pressure, and the trouble arising from the unequal expansion of parts caused by the development of the latent heat of the gas during compression. Of these obstacles to success, the "dead space" is far the most serious, as it fixes a limit to the performance of the pump beyond which it is impossible to carry the compression.

The writer having occasion, some time since, to make a series of investigations on gases very highly compressed, and finding no apparatus, or description of apparatus, adequate to produce the required pressure, devised the following, which appears to entirely eliminate all the difficulties above mentioned.

The accompanying diagram represents a longitudinal section of the pump through its axis. The barrel A, which may be made of any convenient length, is of cast-iron, and is made rather heavy, both for the purpose of resisting great pressure and to absorb and dissipate, to some extent, the heat evolved during action. B is a steel plunger of less diameter than the interior of the pump, so that an annular space is formed between A and B. The plunger passes through two stuffing-boxes, *a* and *b*, whose packings are supported by movable iron rings; thus both are compressed to the requisite degree by means of the screw *c*.

The stuffing-boxes are separated by a ring *d*, thus leaving a small space between them as shown. This space is connected by a small tube C, with the chamber *i*, which latter communicates with the reservoir of gas to be compressed, by means of the cork and tube *l*. The inlet-valve *e* is of steel, conical in form, and carefully ground to its seat. It opens into the passage *f*, thus communicating with the interior of the pump. The exit-valve *g* is also of steel, but smaller than *e*, and is ground to its seat with much care. It opens into the chamber H, and is held firmly in position by a spiral spring of steel. This valve is prolonged at its lower extremity to such an extent that it comes in contact with, and is raised a short distance by, the plunger B, at the completion of its upward stroke. I is a strong tube for the conveyance or storage of the compressed gas. It is firmly secured to the body of the pump by means of a flange on its lower end, and the screw *m*, which forces the flange against the rubber-washer *n*. Such a washer will make a tight and permanent joint under any degree of pressure, provided the flange of the tube I fits the bore of the chamber with tolerable accuracy.

The plunger B may be actuated either by a crank and fly-wheel, or by a lever so arranged that its short arm shall lie in a straight line with the axis of the plunger at the completion of its upward stroke. This arrangement is absolutely necessary when very high pressures are to be produced, as the resistance at and near the completion of the stroke is very great, and could scarcely be overcome without thus taking advantage of the "knee-lever" principle.



The body of the pump is finally partially filled with mercury, as shown by the dotted spaces, to such an extent that at the completion of the upward stroke of the plunger, the annular space around it, together with the passage *f*, are entirely filled, and the chamber H nearly so.

The operation of the apparatus is then as follows: At the downward stroke of the plunger, the valve E is opened, both by its own weight (the mercury having receded from under it at the completion of the stroke) and by the pressure of gas above it. Gas, from the chamber *i*, then rushes through the valve and fills the vacuum above the plunger. At the beginning of the upward stroke, mercury flows into the passage *f*, and closes the valve *e*, by *floating* it into position. As the plunger proceeds upward, the compressed gas may force open the valve *g*, and escape into the chamber H, rising through the mercury there contained; or, if the compression has already advanced to a considerable extent in the chamber, the valve may not open until raised by the end of the plunger; but, at the end of the stroke, the space above the plunger will be entirely filled with mercury, leaving no dead space whatever, and *all* of the barrelful of gas will have passed up into the chamber. The valve *g*, being still held open by the plunger, will allow a small quantity of mercury to pass from the chamber back into the pump when the plunger recedes, thus insuring sufficient mercury in the barrel to completely fill it at the end of the next stroke, after allowing for leakage through the stuffing-box *a*. The object of *two* stuffing-boxes, *a* and *b*, will now be apparent; the small quantity of mercury which must certainly be forced through the box *a* at each stroke, by the great pressure in the pump, and which, if allowed to escape, would very soon exhaust the supply inside, is conveyed by the tube C to the chamber *i*, and is drawn into the pump again at the next stroke.

No leakage occurs through the box *b*, as the pressure sustained by it is only that due to the height of the short column of mercury in the vertical part of the tube C.

It will be noticed that the upper portion of the interior of the pump-barrel contracts gradually toward the valve-passage; this is to prevent small bubbles of compressed gas sticking to the walls, and allowing the advancing mercury to flow past them, as might happen if the contraction was abrupt.

* A paper read before the American Institute of Mining Engineers, at the Cleveland Meeting, October, 1875.

[Chemical News.]

USE OF THE SPRENGEL VACUUM-PUMP.

By ERNEST FRANCIS.

THE difficulty of filling tubes with mercury so that air may be excluded is well known, and instruments in which this condition is attained are highly prized. The ordinary process of filling barometers by boiling is tedious and unsatisfactory, more especially to those unused to the operation.

It has been found that the improved form of the Sprengel pump affords an admirable means of accomplishing the operation, and adds another to the numerous good qualities for which the instrument is famed. The process is easy and would enable barometers to be filled in the laboratory with perfect accuracy. It has the additional advantage of being applicable to tubes of any calibre.

The operation is performed by connecting and exhausting the barometer-tube; the outflow-orifice of the pump being then stopped, mercury passes in and fills the exhausted tube.

Further details may be gathered from the accompanying diagram, but the arrangement would vary slightly with the shape of the tube to be filled. The diagram shows a Bunsen syphon barometer, connected to the pump at A by vulcanized tubing, with the joint surrounded by a tube filled with mercury. After exhaustion, the end of the pump C is closed either with the finger or by a specially furnished clamp or stop-cock. The mercury which is kept flowing from the reservoir then ascends and completely fills the barometer. The mercury falls over the bend to the point B, but without sufficient force to break the tube. The inflow of mercury is regulated by the clamp D. When full the barometer can be safely disconnected with a little care, and the excess of mercury poured out. For filling straight tubes the part A can be bent and connected to the barometer inclined downwards. It is almost needless to add that the barometer during the filling must be supported by a clip or otherwise.

A barometer filled in this manner answered every test most satisfactorily. The tube became completely filled with clear, bright mercury, no trace of air being visible at any part. Tested by repeated gentle tiltings it gave no dull sound, and finally the vacuous part being surrounded by hot water, produced no alteration in the height of the mercurial column.

In conclusion I would suggest that the same process might prove satisfactory for filling *thermometer* and other tubes with mercury. GOVERNMENT LABORATORY, TRINIDAD, B.W.I.

THE GELATINO-BROMIDE EMULSION.

By Rev. H. G. PALMER, M.A.*

I PROPOSE to notice, first, the main causes of failure with gelatine, and these, I think, may be resolved into three:

1. The character of the light in the working-room.
2. Want of patience in preparing the emulsion.
3. The length of time allowed for the plate to dry spontaneously.

As to No. 1 of these causes, I may remark that it is a mistake to imagine, as some do, that gelatine emulsion and plates can only be prepared in the gloomiest of lights, and therefore in the greatest discomfort. It is not the quantity of light in the laboratory which is so often the cause of fog so much as its character. The first thing, then, is to ascertain the amount and quality of light by which this process can be worked without risk. I have made many experiments with different kinds of ruby and professedly non-actinic glass, and find in practice that Forrest's non-actinic orange, plus one thickness of orange tissue-paper, gives absolute freedom from fog, even with bright sunlight passing through it. Accordingly, in my work-room I have a wooden lantern standing in the centre of the top of my drying-cupboard, by the light of which I work with the greatest ease and safety. The accompanying drawing of it will explain itself (No. 1). The lamp burns paraffine and gives a very bright light, and I wrap around the glass one thickness orange tissue. In the grooves A A A are three sheets of Forrest's non-actinic orange glass (each pane being 18 inches by 12 inches), and at the top and bottom of the back there are apertures to give ingress and egress to the air.

Fig. 1.

The next cause of failure on my list arises mainly from overhaste in passing the emulsion through the fine linen filter. The gelatine receives a preliminary soaking of half an hour; it is then placed in a hot bath, frequent shaking being administered to effect the solution of the pellicle; it is next passed through fine linen to remove bubbles, etc. But very often the last operation is performed too soon, and, on examination, the linen is found to contain a portion of the pellicle undissolved. The result of this will naturally be a batch of plates which will afford the thinnest of negatives, and which will obstinately decline intensification of any sort or kind. To avoid this, the emulsion should be mixed, and solution of the pellicle obtained by frequent stirrings with a glass rod (the bottle containing the gelatine being in a hot bath the while); and on no account should the emulsion be passed through the filter so long as any soft substance can be detected with the rod at the bottom of the bottle. The result of too long protraction of the process of drying is not evidenced until the time comes to develop a picture, and then it will make itself manifest in blisters in the centre and in frillings at the margin of the plate. In damp weather it is sometimes well-nigh impossible to get the plates to dry spontaneously; and it is no easy matter to raise the temperature of the room to just the proper height to secure speedy drying. The small apparatus (for the idea of which I am indebted to Mr. Kennett) depicted in plate 2 answers admirably for this purpose. A is an iron cone, firmly fastened to a circular base of the same metal; B is the inlet for air, with movable cover; C, to regulate the supply; D is the outlet, and this is fixed in an aperture at the bottom of the drying-cupboard; the lamp underneath is called the Rechaud spirit-lamp. Drawing No. 3 will explain the cupboard and its appliances; mine contains four shelves accurately levelled, and sufficiently capacious to hold eight dozen quarter plates, or two dozen 9 by 7. The top is my operating-table, and in front are light-tight doors, with lock and key to baffle inquisitive visitors to the dark-room. After coating a batch of plates, they are placed in succession upon the shelves, the doors are closed, the lamp lighted, the supply of hot air regulated at pleasure, and in a few hours the whole batch will be ready for use. Without doubt, the simplest and safest plan is to prepare the emulsion with Kennett's pellicle. This is done as follows: Two ounces of distilled water are poured upon eighty grains of pellicle in a four-ounce wide-mouthed bottle; in about half an hour the bottle is placed in a vessel of hot water, and then roughly stirred until the gelatine is entirely dissolved. If, however, it is desired to make the emulsion *ab initio*, the following formula will be found to answer well:

Nelson's gelatine	40 grains.
Distilled water	14 drachms.
Alcohol	2 "
Bromide of potassium	25 grains.
Nitrate of silver	40 "
20-grain per oz. solution of bromide of ammonium	2 drops.

Let the gelatine be soaked for five or six hours in water, and be then drained. The bromide is next dissolved in seven drachms of water, and poured upon the gelatine. The latter is now treated to a hot bath, and stirred with a glass rod until complete solution has taken place. The silver is then dissolved in seven drachms of water, and is poured little by little into the gelatine, the whole being frequently shaken. After this, two drachms of alcohol and two drops of bromide of ammonia are added; emulsion is poured into a flat dish until it has set; it is then cut into strips with a slip of glass, placed in a sieve with fine linen stretched over the bottom, suspended under a tap to which a rose has been fastened, and thoroughly washed for six hours at least. After draining, it is treated to a hot-water bath until completely liquefied, and then distilled water is added to bring up the amount to two ounces.

I will now give the details of the preparation of gelatine

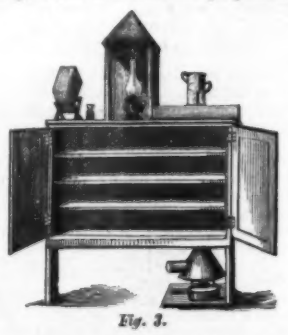


Fig. 3.

dry plates in proper sequence. On the top of the drying-cupboard are the following articles: The wooden lantern is in the centre, and to the right of it a flat hot-water tin, covered with a sheet or two of blotting-paper. This is used to give warmth to plates, if I am coating those of large size. Small plates do not require to be warmed. On the right side also I have an infant's food-warmer with the burner alight, a little hot water in the tin boiler, and the porcelain cup clean, empty, and ready to receive the emulsion. I need hardly say that the light emitted by the burner must be carefully screened off with brown paper. On the left are the clean plates, a brush for sweeping each plate before coating, a pneumatic plate-holder, and a glass rod in a vessel of warm water (for large plates only). It is unnecessary to urge the importance of clean plates, but I may notice here an advantage of this process over every other with which I am acquainted—namely, that old gelatine plates need to be merely placed under a tap of hot water until the film is dissolved, then thoroughly rinsed and polished with cloth and leather without further trouble. The emulsion must be filtered through fine linen into the porcelain cup of the food-warmer, and the filter-bag should rest against the side of the vessel to prevent bubbles in the filtered emulsion. If the plates are of small size, it will be found that the gelatine flows after a little practice as easily as collodion without the assistance of a glass rod. Large plates, however, must be warmed (or the gelatine will chill and thicken), and can then be coated with the greatest ease as follows: A pool is poured from the lip of the cup along the right-hand margin of the plate from corner to corner. The emulsion is then swept before the glass rod to the other end, without endeavoring in the least to secure evenness of film. This is effected by now flowing over a fresh supply of emulsion, and the surplus is disposed of by allowing a corner of the plate to touch the side of the cup. The two things to be avoided in the process of coating are bubbles on the film or in the emulsion, and over-draining of the plate and consequent thinness and weakness of the negative.

The whole process, whether with small or large plates, is done with the greatest ease and rapidity, the chief desideratum for comfortable working being a pneumatic holder, which may be relied upon to cling fast to its plate. As soon as the coating is effected, the plates are put one by one upon the level shelf below, until all are finished; the doors of the drying-cupboard are closed; the lamp below is lighted; and a stream of hot air is sent over the film until they are dry.

As regards exposure, it should be borne in mind that Kennett's rapid pellicle and plates are, with good light, really instantaneous. Nothing can surpass the cloud, wave, and street views taken with this preparation; and for baby portraits it is simply perfection itself. The ordinary pellicle is much slower, and admits of considerable latitude of exposure. On a bright January day I exposed six plates experimentally upon a well-lighted subject, giving (1) 10, (2) 20, (3) 30, (4) 40, (5) 60, and (6) 120 seconds respectively. I developed with a three-grain solution of pyro, using at first one drop of a one-in-sixteen solution of strong ammonia to two

* Read before the Edinburgh Photographic Society.

drachms of developer. All came up to printing density without any intensification. No. 1 was wanting in detail; 2, 4, and 5 were fair negatives; 3 (30 seconds), perfection; 6, spoiled from over-exposure. The lens used was Dallmeyer's medium angle rectilinear for quarter plates, and the stop was the smallest of the five. These ordinary pellicle plates, then, require rather more than half the exposure requisite for a wet plate. I do not recommend any one to deviate from the directions as to developers and the methods of using them supplied by Mr. Kennett. In my own practice, however, I prefer, after washing a plate well till the water flows everywhere upon the film, to soak it for a time in three-grain pyro, and to bring out the picture with one drop of ammonia to a quarter ounce of developer, gradually and cautiously adding the alcohol till printing density has been obtained. If intensification is necessary, no process can compare for safety and certainty with the chloride of copper. The negative is placed in a solution of chloride of copper (the strength seems to matter very little) until the image has disappeared, and then, after abundant washing, a strong alkaline developer brings up the picture to any amount of intensity. I use one drachm of a one-in-sixteen solution of strong ammonia to one ounce of three-grain pyro.

The golden rule to be adopted throughout the development of these plates is: "Give them abundance of water." Nearly all the ills that gelatine films are heir to after exposure are due to insufficient washing. I have found no advantage from backing gelatine plates, save in the case of negatives of interiors. In these it is absolutely necessary to use it if it is desirable to avoid blurring round windows, etc.

Since the above paper was written, the discovery has been made that greater brilliancy and beauty may be obtained from gelatine negatives by substituting mild ale for the water in preparing the emulsion.

[Chemical News.]

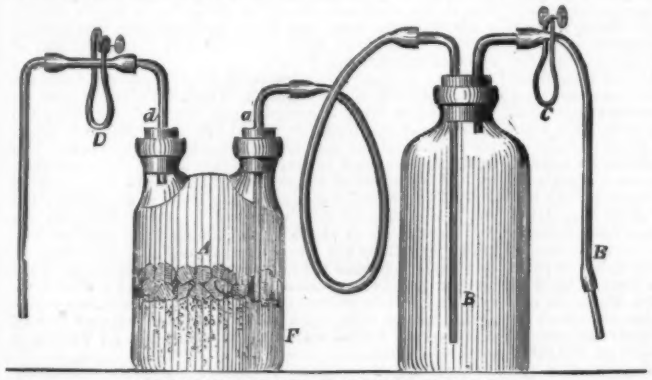
NEW SULPHURETTED HYDROGEN GENERATOR.

By P. CASAMAJOR, Brooklyn, N. Y.

THIS gas-generator possesses two important characteristics in any apparatus suitable:

1. That it gives sulphuretted hydrogen immediately whenever it is wanted.

2. That it does *not* give it when it is *not* wanted, except for a few minutes after being used.



NEW SULPHURETTED HYDROGEN GENERATOR.

Kipp's apparatus, which is the one most generally used for the production of sulphuretted hydrogen, fulfils the condition of being ready to give off the gas at any time, but it has the drawback of being an almost constant generator of gas, which defect is inherent to its construction. One cause of this is that the sulphuret of iron is placed on a wire gauze directly over the dilute sulphuric acid in the lowest globe, and that it keeps falling through and around the wire-gauze, causing a constant production of gas, which must eventually escape either through the glass stopcock, or through the safety-tube on top of the highest globe.

Another cause of the constant production of gas is that, when the stopcock is closed, the dilute sulphuric acid is driven back to a height of about 15 inches. This maintains a pressure in the apparatus which forces the gas out at some part of the ground joints. After a certain portion of the gas has escaped, the dilute sulphuric acid rises in the lowest globe so that it reaches the sulphuret of iron on the sieve, and a fresh supply of gas is produced, driving the liquid to the upper globe as before, and re-establishing the pressure in the apparatus.

The use of Kipp's apparatus having been found inconvenient, I adopted for several years the plan of putting up an apparatus when one was wanted, emptying it out again when not required for use. This generator was merely a bottle with two tubes, one for the egress of the gas and the other for the introduction of dilute sulphuric acid, which latter served also as a safety tube.

This plan is troublesome and inconvenient. If particular care is not taken to wash the sulphuret of iron with water and weak carbonate of soda, and drying it well before putting it away, it will be found oxidized and useless when wanted.

Besides these two generators, which are in general use, others have been proposed, of which I can say that those which have come under my notice have either failed in the important requisite of ceasing to give sulphuretted hydrogen when it is *not* wanted, or are ill-adapted to the production of gas in any considerable quantity.

The new apparatus for generating sulphuretted hydrogen is represented in the woodcut accompanying this article. The bottle marked A is provided with two tubulures, through one of which passes a glass tube, ending at its lowest part in an enlarged portion F, which must, however, be narrow enough to pass through one of the tubulures of the bottle A. This tube must pass through a rubber cork capable of closing the tubulure *a* perfectly.

Before introducing the tube through the tubulure *a*, the enlarged portion is filled with some coarse fibrous material, such as coarse tow. After the tubulure *a* shall have been perfectly closed by the rubber cork, a quantity of shot (about No. 3) is poured into the other tubulures so that it will rise in the bottle to a height of two or three inches. After levelling the shot, pieces of sulphuret of iron are introduced in the bottle, where they will lie on top of the shot.

The presence of shot in contact with the lower part of the tube before mentioned accounts for the necessity of providing this tube with an enlarged portion F, as by this means sufficient space is left for the passage of liquid between the grains of shot, which otherwise would close almost entirely the lower end of the tube. The object of stuffing the enlargement F with tow is to prevent the shot from rising up to the narrow portion of the tube.

After the shot and sulphuret of iron have been introduced, the other tubulure *b* is closed tightly with a rubber cork provided with a tube to lead the gas generated to a wash-bottle. The two portions forming the outlet-tube are united by a rubber tube, which may be entirely closed by means of the screw pinchcock D.

The bottle B is provided with a wide mouth, bearing a rubber cork with two tubes, one of which extends down to the bottom of B and communicates by means of a flexible rubber tube to the glass tube which enters into the bottle A through the tubulure *a*. The other glass tube of bottle B terminates in a flexible rubber tube which may be tightly closed by means of the pinchcock C. The bottle B is filled to about two thirds of its height with dilute sulphuric acid, which is allowed to go to the bottle A whenever the gas is to be generated, and which returns to the bottle B when the apparatus is not in use.

To generate sulphuretted hydrogen with this apparatus, we may observe that if the tubes by which the bottle A communicates to the bottle B are full of liquid, it will merely be necessary to open the screw pinchcock D, which will remove the pressure from the bottle A and allow the dilute sulphuric acid in bottle B to flow into bottle A. If these tubes of communication, including the flexible tube, are not full of liquid, the screw-pinch D should be kept open, and air be driven into the bottle B from the mouth through the tube E by opening the pinchcock C. The pressure exerted in this way on the surface of the bottle B drives the liquid it contains into the tubes of communication, and, after the blowing of air through the tube E has ceased, the liquid continues to flow into A until it reaches the sulphuret of iron, when sulphuretted hydrogen is given off.

On account of the offensive nature of the gas, care should be taken not to draw air from the bottle B into the mouth. This is easily avoided by filling the mouth and lungs with air before blowing into the bottle B. If care is not taken to open the screw pinchcock D before blowing, the gas in the bottle will not be driven forward, but will be mixed with the air from the lungs, and partly find its way into the mouth of the operator. This screw pinchcock D is specially useful in regulating the outlet of sulphuretted hydrogen, and consequently its production.

When no more gas is wanted, the screw pinchcock should be closed entirely, after which a certain pressure is produced in the apparatus from the gas which continues to be formed. After a minute or two the pinchcock C should be opened to remove the pressure from B, and allow not only the liquid in A to flow back into B, but also a certain quantity of gas, by which means the liquid connection between the two bottles is interrupted, and remains so while the apparatus is not in use.

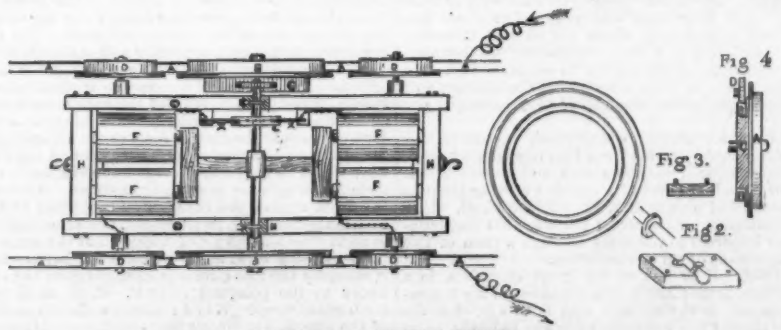
[English Mechanic.]

HOW TO MAKE AN ELECTRIC LOCOMOTIVE ENGINE.

By G. F. CHUTTER.

REFERRING to Fig. 1 the reader will see that on the shaft I of a revolving armature E is fixed a small pinion, which runs against a toothed wheel on inside of driving-wheel B; hence the motion. HH are the two ends of frame into which are screwed or riveted the poles of electro-magnets FF. The sides of frame GG, made of thoroughly dry mahogany or boxwood, are screwed on to HH, so as to just allow the armature E to revolve between the poles of opposite magnets; the armature has six spokes (two only being shown in Fig. 1). A small brass disk J, having six slots in outside edge, is firmly fixed on the shaft I; KK are two springs pressing lightly on disk J.

C is the toothed wheel on same centre as driving-wheel B. The wire best suited for magnets is No. 34, silk-covered (well insulated with paraffin wax), which must be very carefully wound on cardboard or extremely thin boxwood bobbins that fit tightly on cores. The brass springs KK must be so adjusted that, when the armature is level with magnet, they will be over the slots in the disk, thus cutting off current. The wheels must be made of brass, and by allowing the small ones DD to have a play on axles, the engine will run smoothly round the sharpest curves. M is a small brass bearer, let into the wooden sides, into which the shaft I should fit easily, but have no play. Fig. 2 shows a section of shaft with small guide which runs into groove in bearer to keep armature in a right position. There being no rule as to measurements, I have given none, leaving it to the amateur to please his own ideas.



ELECTRIC LOCOMOTIVE ENGINE.

AA are circular rails for engine, which may be made of slips of brass bent round and fastened on to a circular piece of wood (the larger the better—say 6 ft. diameter), or may be as Fig. 3, which is a difficult job, but is much lighter and looks better. Two circles of ¼-in. wood should be made and glued together so that no joint in one shall lie over joint in other; the inside rail should be a little lower than outside one; the driving-wheel should be placed on outside rail.

Section 2. The battery may be any thing to the strength of 6-cell Groves, but bichromates are the best. If the engine is on a table, put the battery underneath, with a wire fastened to each rail; the current will then travel, as shown by dotted lines on Fig. 1, along rail, up driving-wheel, through pinion, brass disk, and springs, then along a wire let into wooden sides of frame, round magnet, and down wheels on other side. The power of this engine lies in the springs being properly regulated, so that the current may pass round magnets at exactly the right time; this engine ought to make (even if it is no larger than Fig. 1) about ten revolutions of a circle 6 ft. diameter per minute.

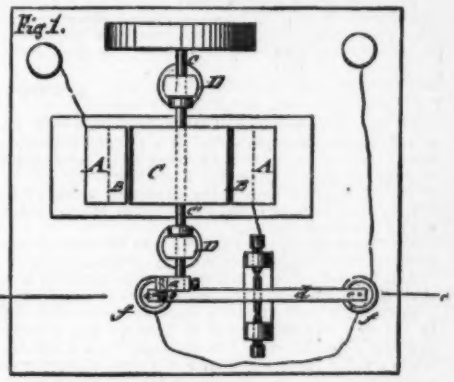
If more power should be wanted, a pinion may be fixed on the other end of shaft I, working against toothed wheel as on other side, but a break must be made with some non-conducting material, or the current would run up one wheel and down the opposite one direct. The best way to overcome this is to have the centre of toothed wheel made of ebonite, as Fig. 4. A is a brass wheel, B section of toothed wheel, C ebonite, D small pinion on shaft. Care should be taken to keep the lines and cogs clean, as the spark that follows wheels soon forms a layer of oxide. An engine about one foot long and large in proportion will carry its own battery or drag it behind in "tender."

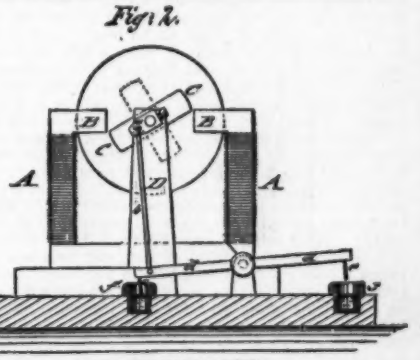
NEW ELECTRO-MAGNETIC ENGINE.

By W. E. SAWYER, New-York.

THE armature revolves between pole-extensions of a fixed magnet, both the poles of the magnet and the centrifugal surface of the armature consisting of long, narrow edges running parallel to the axis of the armature. The current is interrupted and established by points, dipping into quicksilver or other fluid conductor, and suitable connecting mechanism.

A represents an electro-magnet of U-shape, whose pole-ends are made with rectangular, curved, or other extensions, B, that face each other, and the symmetrical axis of the magnet, to present a long surface to the armature C, whose shaft C' turns in bearings of pillars, D. The armature C is thus placed between the poles of the magnet in the magnetic field





NEW ELECTRO-MAGNETIC ENGINE.

of the same, the surface or edge of the ends of the armature being equal in length and width with the faces of the poles, but slightly curved for passing closely to the same when revolving.

A fly-wheel on the armature shaft regulates the motion of the armature, and carries the same over the dead points.

The shaft is connected at the other end by crank *a* and rod *b* with a walking-beam, *d*, centrally fulcrumed and provided with pins *e*, at the ends, that dip alternately into cups, *f*, filled with mercury, or other fluid conductor. The cups are connected to the battery and the fulcrum to the magnet, which is excited at each dipping of the pins, the current being interrupted at the moment when the walking-beam is balanced and both points are outside of the conducting fluid. The armature faces at this moment fully the pole-ends, and is then carried by the fly-wheel away from the same to be again exposed to magnetic attraction on the dipping in of the circuit-closing point.

PHOTOGRAPHS OF THE BLOOD.

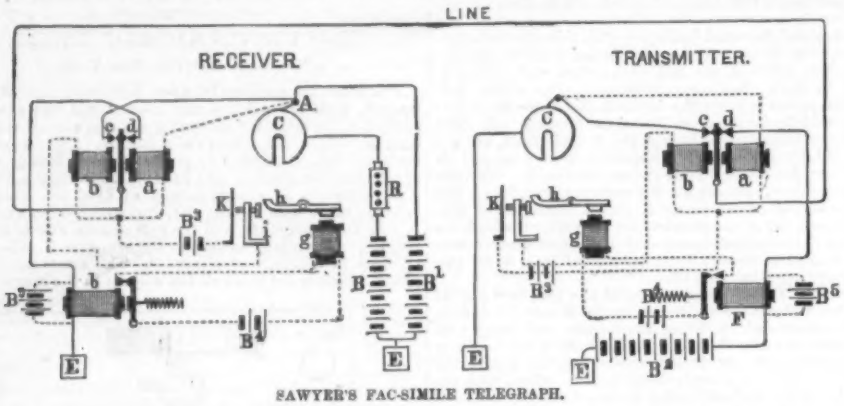
PHOTOGRAPHS of both healthy and diseased blood-corpuscles magnified have been recently taken in Boston, Mass., under the supervision of Drs. Cutter and Harriman. The objectives employed were a $\frac{1}{10}$ and a $\frac{1}{20}$. The red and white corpuscles are shown, the white being nearly ¼ of an inch across the disks.

[Telegrapher.]

FAC-SIMILE TELEGRAPHY.

By W. E. Sawyer.

In response to a request from the editor of *The Telegrapher*, I take pleasure in presenting to telegraphers and electricians a brief account of my fac-simile telegraph, otherwise known as a pantelegraph, or autographic or pantographic telegraph. In doing so I lay no claim to the invention of autographic telegraphy as a function or principle. The idea is very old—older than the Morse telegraph; indeed, it appears to have been one of the first ideas that the possibility of the transmission of intelligence by means of electricity suggested, although Casselli and Meyer abroad are, so far as I know, the only electricians who have succeeded in bringing the idea anywhere near to practicability. The starting-point of all, and one free to the world, is an insulating writing upon a conducting surface, or *vice versa*. This all have, and always have had, in common; and it was with this that, ten years ago, I began the construction of a system, branching off in later years into many complications, but finally returning to most of the simple principles of my first essay.



SAWYER'S FAC-SIMILE TELEGRAPH.

Three things are requisite in a practical copying telegraph:

1. It must at least equal the speed of Morse transmission, say 25 words per minute.

2. It must not require instruments of costly construction, complicated mechanism, or difficult of management.

3. It must be such a system that the sender of a message shall be able to write his message upon ordinary paper.

In all three particulars the system of Casselli is defective; in the first and third, that of Meyer. The objection of a practical public to writing its messages upon a metallic paper, while serious enough to render a system impracticable, is no more serious than the electrical fault. A better conductor of electricity is required than is afforded by the film of metallic paste upon a sheet of paper, and a better, harder, and firmer insulating writing is required than is practically obtainable when one writes in an insulating ink upon such paper.

To overcome distance in its electro-chemical effects, and to obtain speed of transmission, intense battery currents are requisite. Their effect upon the thin metallic film is to burn it, whence result the greatest difficulties. It was after much experimenting in transferring messages written upon ordinary paper to a metallic plate, and thus securing the necessary conducting and insulating conditions, that I perfected a method in which the message is written in any ink containing a little glycerine, or other oily matter, so as not to dry readily. After being thoroughly blotted, the sheet of paper is laid upon a clean plate of zinc, and both are passed between rollers exerting considerable pressure. Very little is perceptible on the plate, but upon sprinkling the plate with an impalpably powdered gum, such as shellac, the lines are brought out sharp and raised, the shellac adhering to the finest lines of glycerine transferred to the plate of zinc. A few seconds' heating of the plate melts the shellac lines, which adhere to the plate with surprising tenacity, but may readily be removed in a caustic-potash bath. It remained for Capt. A. J. Russell, of New-York, to put the finishing touch to the process, by suggesting that, instead of transferring the writing to a cold plate, sprinkling the plate with shellac, and afterwards heating it, the original writing might be sprinkled with shellac, and the plate heated before or during the passage of plate and paper between the rollers. This was an invaluable suggestion, both as securing perfection of transfer and rapidity of execution, for it is not a question of deliberate motion to make the transfer, but to get the plate and paper through the pressure rollers in the shortest possible space of time. They can not be run through so quickly that the shellac upon the writing will not be melted and firmly fixed to the metallic plate. The whole process of transferring does not occupy as much time as is now required to count the words and check a message. From ten to one thousand words can be transferred at a single operation; but estimating that only one ordinary message is to be transferred at a time, an experienced man, with a boy to use the shellac, will transfer two messages in five seconds, or 1440 messages per hour.

The instruments are neither complicated, expensive, nor difficult of management. In the form that has been adopted, they can be manufactured for $60 apiece, and consist in the transmitting or recording parts of a cylinder moving longitudinally on a shaft, and a bent arm, fixed to the shaft, which carries the transmitting or recording point around the cylinder. Motion is imparted to the shaft through a train of two gear-wheels, by means of an electro-motor.

The great essential, or one of the great essentials, in a copying telegraph, is that the sending and receiving instruments shall operate isochronously; that is to say, that the transmitting style and the receiving style shall always be at the same relative point upon the metallic plate and the receiving blank. The plate upon which the message is transferred, which is very thin, is bent around the cylinder and held in place by a clasp. In receiving a message, a sheet of chemically prepared paper is placed upon the same or a similar cylinder. The cylinder is not complete, having a slot cut along its entire length to admit of its being readily lifted off and put on to the shaft. A fine thread is cut in the shaft, into which fits a half nut, forming the centre bearing of one end of the cylinder, the centre bearing of the other end sliding upon the shaft. Thus, as the shaft turns, the cylinder is gradually moved along by the thread. Where but two instruments are used upon a line, there is but one thread—a right-hand thread in one instrument and a left-hand thread in the other; where more than two instruments are upon the line, the shaft of each instrument has both a right hand and a left hand thread, with corresponding half nuts, either of which may be brought to bear upon the shaft and roller centres, in order that the thread may not be abraded. The cylinder is insulated from the shaft, an upright piece serving both to make connection with the cylinder and to prevent the cylinder from turning with the shaft. The transmitting or recording style is carried round the cylinder by the arm fixed to the shaft, either style being brought to bear upon the cylinder at pleasure.

At a point beneath the cylinder, where to stop the arm carrying the style will leave the style just upon the edge of the slot in the cylinder, is an electro-magnetic detent—that is, a projection which prevents the arm and style from going any farther, so long as a current is flowing through the helices of the magnet. Both the arm of the transmitting instrument and that of the receiving instrument arrive at this point before the magnetism is destroyed; both having arrived at this point, the current is removed and the armature of the electro-magnet flies off, releasing the arms, which carry the styles synchronously around the cylinders until both have again reached the detent; and so on indefinitely, each revolution of the shafts and styles moving the cylinders along longitudinally, until finally the styles have drawn fine imaginary lines over the entire surface of the cylinders. Farther along I shall return to the detent and process of transmission.

It is apparent that, to obtain the necessary isochronous action, great regularity of motion is required, as a variation of $\frac{1}{10}$ of an inch between the positions of the transmitting style and the recording style upon the cylinders at any point of this track will distort the writing. To attain this regularity I employ an electro-motor carrying a heavy balance-wheel, making as many as 600 or 700 revolutions per minute. Upon the motor-shaft is a pinion, meshing into a large gear upon the top or cylinder shaft, so that the speed of the balance-wheel is greatly reduced at the top shaft where the work is done, and the variations in regularity of the balance-wheel, very inconsiderable in themselves, are correspondingly reduced. The large gear is loose upon its shaft, but imparts its motion to the shaft by means of friction springs fixed to itself and bearing upon a flange fixed to the shaft. If one instrument is at first inclined to run faster than the other, its arm reaches the electro-magnetic detent before the arm of the other instrument, and stops until the arm of the other instrument reaches the same point. This stoppage does not stop the motor or the large gear, as the friction springs slip on the flange; but the springs exert a governing influence on the motor, slightly slowing it, and in two or three revolutions a perfect reciprocating action sets up between the two instruments, so that each one is dependent upon the other, and both start and are checked exactly together. In sending a message, the transmitting operator calls the receiving station. The receiving operator signals him to go-ahead, and at once sets his motor in motion; but the recording arm and style will not start until the transmitting operator sets his own instrument in motion, when both instruments work together, and neither operator has any thing to do until the message or messages have been transmitted. When the operation is completed the sending operator stops his instrument, whereupon the distant receiving instrument also stops, that being the only signal necessary to give the receiving operator.

All of one series of the electrical circuits are shown in the engraving. C is the cylinder; A, the arm and style; h, the detent lever of electro-magnet g, whose circuit of local battery, B^4, is closed by lever of polarized relay F, polarization of which is effected by local battery B^5. A circuit-changer, a, b, c, d, consists of two electro-magnets controlling a single armature, and operated by local battery B^3 through spring K, standard and set-screw, and arm A. The function of this apparatus is to change the circuit of the line alternately to the style and to the polarized relay F, by the action of which the instruments are kept in synchronism. The circuit-changer accomplishes both a quicker action than is obtained from a single magnet with a retractile spring, and a firmer contact (at least on the side of the retractile spring) than a retractile spring affords. The circuit of the apparatus is shown by the dotted lines. While spring K is touching set-screw in standard i, which is the case as soon as the styles begin to move, the armature is attracted to b magnet and the circuit of the line, which is put to the lever of the armature, to contact c, style A and cylinder to earth or batteries. As soon, however, as arm A strikes the detent h, a projection of the arm also strikes the spring K, with which the arm makes connection so as to close the circuit of magnet a at the same instant that the separation of K and i removes the battery from magnet b, whereby the line circuit is changed from the style and cylinder to the polarized relay F. E, E, E, E represent the earth connections. R is a resistance exceeding the resistance of the line, and in circuit between the receiving cylinder and main battery B and earth. B^1 is a second main battery connected to the style A, and arranged so as to considerably exceed in power battery B which it opposes. These are the transmitting batteries, and they are placed at the *receiving* end of the line, there being nothing but an earth connection at the transmitting end. So long as the transmitting style is bearing upon the conducting surface of the message plate a portion of battery B^1 is diverted into the line, the resistance of R and opposing battery B preventing B^1 from finding there so short a circuit as in the line; what remains of the current of battery B^1 is of course prevented from marking the chemical paper by the opposing battery B, each battery, when battery B^1 is partially diverted into the line, being about balanced in the circuit of B, R, C, A, and B^1. As soon, however, as the transmitting style touches a line of the insulating writing, battery B^1 can find no circuit via the line, and, overcoming battery B, makes a dot or mark upon the chemical paper corresponding in duration to the time the transmitting style is bearing upon the insulating writing. The advantage of this circuit is that, while "tailings" may exist to any extent in the line wire, they never affect the receiving instrument, as there is always a very short circuit for their discharge through battery B^1, and no distinguishable portion can pass from the style to the cylinder and through the heavy resistance R to earth. The longer the line the less the "tailings" affect the receiving instrument, which, while somewhat anomalous, is nevertheless the fact. Batteries of very many small cells, so as to give intensity currents, are the most satisfactory.

I am now enabled to explain the operation of the detent, and the method of regulating the instrument with the use of a single line wire. Back of polarized relay F, at the transmitting instrument, is a third main battery, B^2, whose polarity to the line is opposed to the polarity of main battery B^1. Both the transmitting and the receiving relays are polarized by batteries B^3 in such direction that when battery B^2 flows through them the magnets are depolarized and the armatures fly off by the action of the retractile springs. The receiving relay F can not of course be neutralized until the transmitting arm has arrived at the detent, and owing to batteries B^1 and B^2 being opposed, the transmitting relay F can not be neutralized until the receiving relay is brought into circuit by the arm A arriving at detent h. After the arm leaves the detent, the circuit of the line is through styles and cylinders, and the polarized relay F holds closed the circuit of battery B^4 through detent magnet g. As soon as the arm arrives at the detent h, however, the circuit of the line is changed by the circuit-changer, relay F is depolarized, its armature flies off, the local circuit of detent magnet g is broken, and the detent yields to the advancing mechanism. The entire operation is so rapid, however, as to be hardly appreciable, although the arm A on each instrument is set back a certain degree at every check.

The advantages of the friction connection between the styles and the motive power are several:

1. The governing power over the speed of the instrument.

2. The power it gives of regulating the motion and setting the styles to corresponding positions without in the least deranging the action of the mechanism.

3. The unvarying speed it gives. [In all other instruments brought to a check, the speed of motion of the styles would necessarily be slower at the start than before the check. Perfect as is the pendulum motion of Casselli, its great defect is that at the start and end of its vibrations it moves slowly, while when the pendulum is at a perpendicular it is moving rapidly. This is an important feature in the attainment of speed of transmission.]

As the message to be transmitted is transferred from the paper upon which it is written to a metallic plate, it is in reverse, and to bring it straight upon the receiving blank the instruments are made to run in opposite directions; hence the right-hand and the left hand-threads on the shaft. The message is recorded in deep blue dots upon a white ground; but the operation of the system will from the foregoing be so well understood that I need only quote as a summary the words of a scientist who witnessed the same: "In fact, the words are taken to pieces by the transmitting machine and built up again by the receiving machine." As the transmitting style traverses a line of writing, the recording style drops a row of dots upon the receiving blank; then, both cylinders having moved a degree longitudinally, the styles again traverse them upon a new place and another row of dots appear; and so on until the entire line of writing is built up of little dots.

Concerning the possibilities of the system, it is both my opinion and that of Mr. James G. Smith, formerly Superintendent of the Franklin Telegraph Company, to whose efforts much of our present success is due, that we shall eventually attain a speed of 250 words per minute. The instruments we have at present seldom exceed 50 to 75, but this is due to the gearing, which requires too many revolutions of the motor-shaft to one of the cylinder-shaft. This is an easy matter to rectify, and future instruments will be calculated for greater speed, although the speed now attained, in comparison with that of the Morse telegraph, is sufficient; indeed, taken in connection with points of simplicity and the fact that it is impossible for an error to be made in a message, the pantelegraph at 25 words per minute is a practical system, and superior to an automatic telegraph giving a speed of two or three million words per minute, or somewhere near two or three million words—it is unnecessary to be precise.

It has always been observed that the faster we have run the instruments the better the work they have done; but this is not remarkable in view of the fact that the greater the momentum of the balance-wheel, necessarily the less will it feel outside disturbing influences. The practical limits of the system will be found in the number of electrical impulses per minute that a wire can accommodate. Mr. Smith and I have found it possible to transmit from New-York to Washington 30,000 clean-cut and well-reported dots per minute, say 100,000 as the capability, if we assume upon the time duration of each dot. It requires, with close, ordinarily fine writing, an average of 12 dots to a fac-simile letter. This would give us, with 30,000 dots, 2500 letters, or 500 words per minute. We therefore think we are safe in estimating upon one half that number, or 250 words, while at the same time to make a copying telegraph a practical success, other things considered, as before intimated, it is only necessary to about equal the speed of Morse transmission. The machine does not get tired, and whether skill in its operation is requisite or not I leave each telegrapher to decide for himself, having personally no doubt as to what his decision will be.

RESISTANCE OF ELECTRICAL CONDUCTORS WHEN IN MOTION.

M. Edlund has brought to bear a new argument in favor of his theory of electricity, by showing that the resistance of a conductor is affected by its motion. Water is allowed to flow through a long tube having three electrodes of gold wire admitted at its ends and centre. A battery of two Daniell's cells has one terminal connected with the centre electrode, and the other with two of the terminals of a delicate differential astatic galvanometer. The two end electrodes are connected with the other terminals of the galvanometer. The current from the battery divides, and half passes through the tube in each direction. By suitably varying the resistances the galvanometer needle will now be at rest. When the water is caused to flow through the tube, however, the resistance in one direction will be increased, and that in the other diminished, since, according to Edlund's theory the current is pro-

portional to the amount of ether flowing through a given section per second. Accordingly the needle should deviate, as, in fact, it does. To eliminate the effects of polarization, the current was inverted without changing the result. That the deviations may be regular, it is essential that the liquid should have a great resistance, and the amount of deviation is almost independent of this resistance. Two series of observations were made, one with distilled water, the other with alcohol and water, and gave similar results. A third series with aqueduct water gave the same result. Finally, equal currents were sent in opposite directions through the pipe, when they produced no effect on the needle, but as soon as the liquid was set in motion a deviation was always obtained indicating that the resistance was greater in one direction than in the other. These two methods of observation lead to the same result, foreseen by the theory of Edlund, namely, that the galvanic resistance diminishes if the conductor moves in the same direction as the galvanic current and increases on the contrary if the other two currents move in opposite directions.—*Philosophical Magazine.*

COLLODIO-BROMIDE PROCESS.

AT the last meeting of the Photographic Society of Great Britain Mr. William F. Henry read a short paper in which he described his method of preparing emulsion-plates. He said: By the kindness of Herr Warnerke in furnishing me with his formula for a bromide of zinc emulsion, I have been enabled to make some experiments in the direction of simple washed dry plates; and, so far, my experience informs me the zinc emulsion promises to give the most rapid and in every way most satisfactory collodion dry plate, the only point yet remaining to be ascertained being its keeping qualities.

The formula given to me was, for one ounce of emulsion:

Nitrate of silver	17 grains.
Bromide of zinc	9½ "
Aqua regia	2½ minims.

By multiplying these amounts we arrive at more workable quantities. Herr Warnerke directed me to add the silver to the collodion first, and allow it to stand for twelve hours or so. But I have found no advantage in this; on the contrary, it is easier to emulsify when the collodion is bromized first. And here I would observe to amateurs like myself, the surest way of getting all the silver into the emulsion is to dissolve it in a clean bottle by the aid of heat, and then pour in the bromized collodion; the act of pouring in thoroughly emulsifies the mixture without the necessity of violent agitation. This emulsion requires to stand for a week or ten days before being used, for the reason that before that time it gives only a thin film, but after the lapse of that time it acquires a very thick and creamy consistency and is more sensitive.

The zinc being easily soluble in alcohol, there is no difficulty either in keeping it or in mixing. I have found with this formula a strong disposition to fog, which condition, though balanced by the density afforded by the zinc, is not desirable; this is corrected by the addition of iodine.

Plates made in this way need neither organifier nor redevelopment to confer density, as may be seen by examining the specimens sent round, which were taken by three seconds' exposure to a gas-flame. I have succeeded, as Herr Warnerke and Mr. Nesbit know, in obtaining a thoroughly-exposed transparency in one second.

PRESERVING SENSITIVE PHOTO-PAPER.

THE method which has given in our hands the most satisfactory results is the plan of floating the paper, after it has passed the silver-bath, upon a solution of citric acid. The strength of the solution is immaterial, depending upon the time of year, the strength of the bath, and the length of time the paper is required to keep. From five to ten grains to the ounce of water have been recommended, and the former strength we have found ample for all the requirements of either the amateur or professional photographer. The citric acid when thus applied forms citrate of silver *in the paper*—not in the solution, as would be the case if a sufficient quantity were added directly to the bath; hence the advantage of applying it after the silver chloride has been formed. We have kept paper prepared in this manner for more than two months without noticing any deterioration in its qualities. Fuming with ammonia will in some cases prove beneficial, more especially when the paper has been long kept, but is not absolutely necessary.

If the fuming process be adopted, it is very important that the paper be perfectly dry when exposed to the ammoniacal vapor. If this be not the case, the paper will either discolor under the action of the alkali, or the prints will be "mealy" and unequal in tone. The operation is performed by suspending the sensitized paper in a box or case in which is placed a vessel containing liquid ammonia, or a few lumps of fresh carbonate of ammonia. An alternative method is recommended by some; namely, fuming the pads which are placed behind the paper in the pressure-frame; these may be "fumed" in the same manner as the paper, and should be perfectly dry.—*British Journal of Photography.*

PHOTOGRAPHS IN COLORS.

FROM a given negative there are obtained as many similar negatives as are required, the number of these being determined by the number of colors to be combined together. These negatives are arranged in such a manner that, by applying with a pencil a sufficiently opaque color, various parts of the plate are covered. For example: on the plate which should give the monochrome yellow all the parts are covered which are *not* to contain yellow in the condition either of a simple or composite color. Upon the plate which is required to furnish blue only the whole of those portions of the surface are covered which are not to be blue or a combination in which blue forms an element; and in a similar manner with each of the other negatives intended to furnish respectively the monochromes red, brown, or other color as required. These reserved portions are arranged agreeably with the taste of the artist, according to the result which it is desired to obtain. The negatives thus prepared are printed from separately. With the yellow negative a monochrome of that color is printed upon a yellow pigmented tissue; and so with the other plates, using tissues of blue, red, or other color, as the case may be.

The development of the images is effected in a manner similar to that in which it is performed in the carbon process; but, as a temporary support, stearine paper or a polished metal plate covered with a fatty substance may be employed. The various portions having been all developed, the mounting of the polychromatic image may be proceeded with by the juxtaposition of the proofs, as we shall presently describe, the "registration" of the various parts being kept by means of certain marks previously made on the original negative. The mounting is performed by immersion in water—first on the sheet of paper or permanent support, then of the monochrome which it is desired to apply first. The permanent support is covered with a thin sheet or layer of gelatine, which is softened by the water, as also is the layer which forms the monochrome; and when they are brought together by the aid of suitable pressure and left to dry spontaneously, the adhesion of the two layers is complete, whilst the temporary support is detached, the image it previously bore having been transferred to the permanent support. After this operation has been completed all the other monochromes are applied and transferred in a similar manner, the surface of the picture being washed, by means of benzole or ether, between each application of color, in order to insure the removal of any fatty or resinous substance which might adhere to it on its being separated from its temporary support. When the whole of the monochromes have been thus mounted, the completed picture is immersed in a solution of alum, and after being rinsed with water it is finished.

In lieu of employing the action of light to obtain each monochrome, typographic or lithographic processes may be substituted therefor in order to obtain a series of superposed tints of various colors, including metal—such, for example, as silver, gold, and the like—combined in such a manner that their united effect, added to a final shade supplied by photography with the carbon process, produces the desired result.

TARTARIC ACID.

By ROBERT WARINGTON.

TARTARIC acid was first obtained in a separate form by Scheele in 1769. It occurs, like citric acid, in many vegetable juices. The source from which it has always been prepared on the large scale is the grape. Grapes contain a considerable, but variable amount of acid tartrate of potassium, with probably a little tartrate of calcium, and some free tartaric acid. When grape-juice is fermented, and alchohol produced, the acid tartrate of potassium is gradually thrown out of solution, being insoluble in spirit. A crystalline deposit of the acid tartrate of potassium, with some tartrate of calcium, is formed on the sides of the casks, and is known as "argol." At the same time a more bulky precipitate is separated, consisting of yeast, and the various suspended matters of the must; this precipitate, which is known as "lees," also contains a considerable amout of tartrates, thrown out of solution by the formation of alcohol. From these two products, argol and lees, a purer form of bitartrate of potassium is prepared by a rough process of solution in hot-water and crystallization; the substance thus obtained is known as "tartar." This tartar is always more or less highly colored. By a subsequent process of refinement, it is obtained without color, and is known as "cream of tartar." Nearly the whole of the tartaric acid manufactured in this country is made from colored tartars. Argols and lees are also used, but to a much smaller extent.

Every country producing wine does not manufacture tartar. If the wine is plastered, the quantity of bitartrate of potassium deposited during fermentation is greatly diminished, tartrate of calcium being formed instead; in such cases the lees contain too little bitartrate to pay for its extraction. Plastering is effected by treading plaster (a baked native sulphate of calcium), with the grapes. This process is almost universal in Spain, is common in the south of France, and is adopted in some of the Greek islands, and in the Marsala district of Sicily; in other districts of Sicily, in Italy, Germany, and a great part of France, plastering is not practised.

Italy exports nearly the whole of the colored tartars used in England; a small amount of colored tartar, and a good deal of cream, come to us from Bordeaux and Marseilles. The total imports of tartar recorded in the Customs' bills of entry, for 1875, amounted to 6765 casks, of which 2295 casks were from Bordeaux and Marseilles, and consisted in greatest part of cream. The weight from colored tartar imported might be from these data, 2000 to 1500 tons. The amount of tartar used, calculated from the tartaric acid made would be 1650 tons. It must be recollected, however, that tartar is used for other purposes, besides the manufacture of tartaric acid. The records in the bills of entry are also liable to serious errors, both of excess and deficiency. Besides tartar and argol wine lees are imported from Spain, Italy, France, and Greece. About 1400 tons of wine lees were employed last year in this country for the manufacture of tartaric acid.

The best class of colored tartars consist of nearly pure bitartrate of potassium; such tartars, as those of Messina, contain about 76 per cent of tartaric acid, of which 1¼ to 3½ exists as tartrate of calcium. Good ordinary tartar, as that of Naples (St. Antimo), will contain 74 to 75 per cent of tartaric acid, of which 3 to 4½ is present as tartrate of calcium. Vinaccia tartar is of lower quality; it is prepared in a variety of districts from the skins and solid matter of the grape which remain after pressing; it will contain about 70 to 73 per cent of tartaric acid, 5 to 7 per cent being in the state of calcium tartrate.

Argol being a natural, and not a manufactured, product, has a much wider range of composition than tartar. Superior qualities are equal to tartar, while very inferior kinds are scarcely better than good lees. The tartaric acid varies from 40 to 70 per cent, and is always chiefly in the form of bitartrate of potassium. Sulphur is a frequent ingredient, derived from the practice of sulphuring the casks.

Lees, compared with tartar or argol, furnish a very inferior source of tartaric acid. They contain a great bulk of vegetable matter, and all the dirt that has accumulated in processes not remarkable for cleanliness. Lees have been largely used as manure; their general employment as a source of tartaric acid seems comparatively recent. The composition of lees varies very much according as the wine has been plastered or not.

We may now pass from the materials used to the process of manufacture.

The proposal to use the hydrated sulphate of calcium, which, as one of the products of the tartaric acid manufacture, is always at hand, seems to have originated with M. Desfosses, and this process is the one which is, I believe, now universally adopted in this country.

The method adopted in England is to add the tartar gradually to a boiling mixture of whiting and water, till the whiting is consumed and the tartar neutralized. A sufficient quantity of wet gypsum is then added to decompose the resulting neutral tartrate of potassium, the agitation of the whole being continued for some time. The result is a dense precipitate of crystalline tartrate of calcium (mixed with all the insoluble matters of the original tartar), and a solution of sulphate of potassium, colored, slightly alkaline, and containing some sulphate of calcium in solution.

It is quite true that this sulphate of potassium liquor contains some tartaric acid in solution. This tartaric does not exist, as books tell us, as tartrate of calcium dissolved in sulphate of potassium, but is simply a residue of neutral tartrate of potassium which the gypsum has failed to decompose. In fact, if to this sulphate of potassium liquor an acid be added, a precipitate of bitartrate of potassium is produced on standing; and this is the best and most accurate mode of determining the amount of tartaric acid that may be present, bitartrate of potassium being very insoluble in a solution of sulphate of potassium. Although the action of the gypsum is not quite perfect, it may by care be made nearly so, and the advantages of its use are believed to be greater than the disadvantages.

The sulphate of potassium liquor is boiled down and allowed to crystallize; the resulting crude sulphate of potassium is one of the valuable products of the tartaric acid manufacture. The crude salt will contain about 90 per cent of real sulphate of potassium, the impurities being chiefly water, gypsum, a little carbonate of calcium, and organic matter. If the decomposition has been badly conducted, tartrates and carbonates may be present in notable quantity.

By no means all the potash present in the tartar is recovered by the manufacturer. Some of the washings of the tartrate of calcium are too weak to pay for concentration, and some potash remains behind with the tartrate of calcium, and passes into the tartaric acid liquors. On the whole, I do not think that more than 80 per cent of the potash present in the tartar is recovered, and this estimate is probably too high. Assuming it, however, to be true, the amount of 90 per cent sulphate of potassium produced last year in the tartaric acid factories of this country should be about 745 tons.

The tartrate of calcium having been washed on a vacuum filter is mixed with water, and decomposed with sulphuric acid. The test by which an excess of sulphuric acid is recognized, the mode of evaporation, the granulation, etc., are quite similar to the methods employed in the case of citric acid. The final crystallization of the bright liquor is, however, conducted in deep cylindrical leaden vessels, about two feet high, and not in the shallow trays used for citric acid.

The mother-liquor remaining after three crystallizations have been taken is precipitated with whiting, as in the case of citric acid, but the result is in some respects very different. If a solution of tartaric acid, containing ferric oxide, or alumina, is treated with chalk, the iron and aluminium are precipitated along with the tartrate of calcium; it follows that precipitation with chalk will not purify tartaric liquors from these substances. If, however, the iron is in the ferrous state, a considerable amount will remain in solution after boiling with chalk. In a laboratory experiment, in which an old liquor of known composition was treated with chalk in the usual manner, I found that only about 1 per cent of the aluminium, 3½ per cent of the phosphoric acid, and 30 per cent of the iron present were removed by this method of purification. It appears, therefore, that in a tartaric acid factory in which iron, aluminium, and phosphoric acid are continually being introduced in small quantities in the tartar, the whiting, and perhaps in the animal charcoal used, an accumulation of aluminium and phosphoric acid in the liquors will gradually take place, the accumulation being greater in proportion to the impurity of the materials used. When a factory has been newly started the mischief is perhaps not felt for a few years. Gradually more and more free sulphuric acid has to be employed to induce the liquors to crystallize; this excess of sulphuric acid occasions a greater decomposition of tartaric acid during the evaporations, and oxalic and probably other acids are produced, which further load the old liquor with worthless matter. At last the old liquor becomes intractable. It is very thick, and if induced to crystallize, it yields potash-alum and oxalic acid, but no tartaric acid can be obtained from it.

Kestner's process for extracting tartaric acid is employed in Germany, and is specially adapted for the treatment of low argols and lees. The tartaric matter is in this process heated with hydrochloric acid, which dissolves both bitartrate of potassium and tartrate of calcium; the hydrochloric solution is then decanted from the undissolved matter, and the tartaric acid it contains precipitated by neutralization with chalk or lime. The remainder of the process is similar to that already described.

The amount of tartaric acid manufactured in England in 1875 is estimated at about 1350 tons; there are six factories, all in the neighborhood of London.

OLBERS' COMET OF 1815.

THE comet discovered by Olbers, at Bremen, on March 6, 1815, and with which his name has been usually associated, belongs to the group the members of which revolve in periods a few years less than the period of the planet Uranus.

When first detected, the comet is said to have been barely visible in a good achromatic, and, according to the *Zeitschrift für Astronomie*, was not discernible without telescopic aid at any time; it is, however, upon record that in Russia it was seen with the naked eye. The last observation was made by Gauss at Göttingen, on August 25th, 1815.

According to Bessel, the mean motion at the instant of perihelion passage in 1815 corresponded to a period of revolution of 27,046.9 days, and he found that this would be diminished 824.5 days by the united action of the planets Jupiter, Saturn, and Uranus, thus obtaining 26,222.4 days for the actual revolution, and fixing the next arrival at perihelion o 1887, February 9.4. Beyond doubt, however, this date may now admit of a closer determination, and very probably we may soon hear of a further investigation being undertaken. The original observations made at the Observatory of Paris, and those at one or two other observatories in greater or less detail, are in our possession, and will admit of more accurate reduction than has yet been effected; while a more complete computation of the perturbations with the improved values for the masses of the disturbing planets must tend to diminish the uncertainty that at present exists with regard to the possible error of Bessel's determination of the date of next passage through perihelion. If this should fall about 1887, February 9, as he computed, we might expect that the comet would be detected in September previous in the constellation Monoceros; its intensity of light would gradually increase until its nearest approach to the earth (0.5) at the end of the year, when it might be a conspicuous naked eye object in Ursa Major, within 20° N.P.D., and possibly it would be observable till the following May.—*Nature.*

PROFESSOR WATSON, of Ann Arbor, reports the discovery of a new planet on the night of April 16. It shines like a star of the eleventh magnitude, and is located in the constellation Virgo.

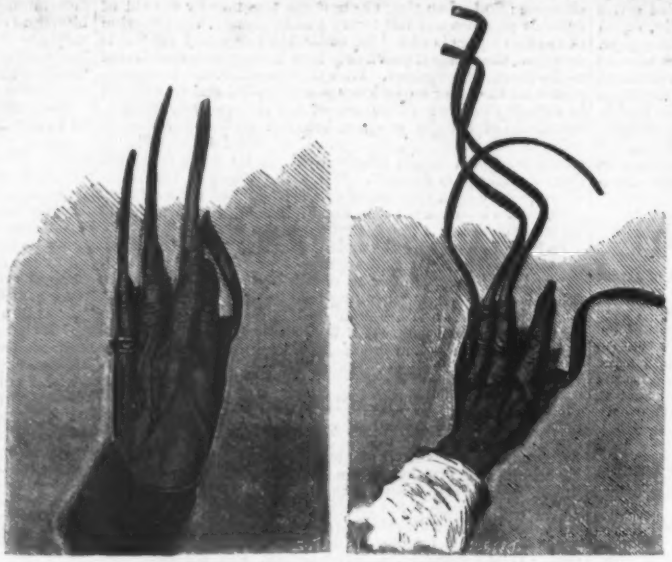
[Condensed from La Nature.]

CHINESE FINGER-NAILS.

ONE of the most curious customs, the existence of which may justly be charged to the vagaries of fashion, is that which impels the upper classes of China and Indo-China to allow their finger-nails to grow to the most extraordinary lengths and to assume strangely-fantastic forms. It is common to find in China men and women whose nails measure from 1½ to 1¾ inches from the retro-ungueal fold to the free extremity. In Siam, Annam, and Cochin China the habit is carried to a remarkable extent, and human claws, singular in their very enormity, are popularly considered marks of beauty and gentility.

The accompanying engravings are taken from photographs made from the hands of two Annamese noblemen. The hand on the left is armed with nails measuring from four to nearly five inches in length, curved inward almost like talons. The thumb nail is very oddly trained first to a curve and then to form a spiral. The nail of the index-finger is cut short, in order to allow of the usage of that finger for prehensile purposes, the other fingers being practically useless for picking up small objects.

In the second engraving, on the right, the nail of the fore-finger is likewise comparatively short, but those of the rest of the hand exhibit an astonishing exuberance, and measure from 16 to 18 inches in length. The spiral on the thumb is fully twice as long as that referred to in the preceding example, and is marked by a much more pronounced curve. It will be observed also that the horny matter is hypertrophied or thickened, a condition probably caused by the use of particular agents or some mode of development calculated to render the secretion more abundant. The excessive thickness serves in a measure to explain the strength of the nails, which otherwise, owing to their growth, it would appear would become enfeebled.



FINGER-NAILS OF ANNAMESE NOBLEMEN.

Our third illustration represents a Siamese comedian dressed to impersonate a great nobleman. Whether the rank of the wearer is indicated by length of nails is not known, but the actor has furnished himself with false appendages of metal, of inordinate size, the better to complete his costume.

The thought will doubtless suggest itself that this apparently abnormal growth of the nails is not in fact abnormal, but just the reverse. Among the refined of civilized nations the nails are invariably trimmed and their development constantly repressed, while among others manual work accomplishes the same object through the breaking and tearing away of the fragile horny matter. It has been pointed out that of all animals man is the worst provided by nature with physical means of offence and defence. The growth of the Chinese finger-nails may throw a doubt upon this assertion, for, beyond being a subject of simple curiosity, the fact leads to the idea that by proper cultivation the human nail may be converted into a claw capable of giving severe wounds. We might add still further to this belief expressed by *La Nature* that it is generally credited that the human nail has a poisonous property, and this appears to be substantiated by the swelling and inflammation which frequently follows the scratching of even small insect-bites until the blood is drawn. This being the case, a "clawing" by an irate John Chinaman—and such is that almond-eyed individual's favorite mode of combat—might lead to more serious injuries than are now supposed possible.

SIAMESE ACTOR DRESSED AS AN ANNAMESE NOBLEMAN.

THE CANKER-WORM.

By A. S. PACKARD, Jr.

LET us now examine the life-history of a canker-worm. And here we will confine ourselves to a single species, the *Anisopteryx vernata* of Peck, which appears in the spring, not touching at present on the autumnal species. About the first of May, at the time when the leaves of the apple are unfolding, the young canker-worms break through the eggs, which have been laid earlier in the season, in March and April, in patches on the bark of the trunk and limbs. They may be soon found clustering on the terminal buds and partly unfolded leaves, and are then about a line in length, and not much thicker than a bit of thick thread.

How they grow and devour every green thing on the tree is too well known to the fruit-raisers in the eastern part of the State. Fortunately, owing to the want of wings, the female is exceedingly sedentary, and year after year the trees of particular orchards and towns are defoliated and turned brown, while adjoining orchards and towns scarcely suffer. By the 20th of June in Essex County, Mass., the orchard looks as if a fire had run through it. At that date the worms are fully fed, and they then descend to the ground, letting themselves down by a silken thread. At this time I have destroyed thousands by jarring the tree and collecting those which fall down. I have watched old and young robins busily engaged in eating them, and from the number of toads in my garden, gathered about under the trees, I feel confident that they eat multitudes of them.

The worms at once enter the ground, change to chrysalids several inches below the surface, near the trunk of the tree, and there remain until the early days of March and April, when the wingless females ascend the trees, and the winged males may be seen fluttering about.

I took pains last spring, in the middle of April, to count the number of these moths on my apple-trees, fourteen in number, averaging from six to seven inches in thickness, besides three elms. They were more abundant on the apple-trees than the elms. But on those seventeen trees there were counted, adhering mostly to the tarred paper, 1000 males and 300 females. The spring of 1875 was cold and backward, and few moths were seen before this date. From these data we can ascertain approximately the relative numerical proportions between the sexes, which seems to approximate five males to one female.

The species I have referred to is the spring moth, the *Anisopteryx vernata* of Peck, but not of Harris. The other species is much less abundant in the adult condition, and only appears in the autumn. The wings are thicker than those of *vernata*, and the caterpillar has an additional pair of proplegs, though so short as to be useless. I find that most of the damage is done by the caterpillars of *vernata*. On June 15th, 1875, I collected 537 caterpillars from the apple-trees in my garden. Of these 520 were *vernata*, and 27 were the young of the autumn species. Peck, in his account published in 1795, states that *vernata* does the principal damage.

As for remedies, the use of printer's ink laid on tarred paper is the cheapest, though the ink should be applied every day or two. The use of tin troughs of oil surrounding the tree is almost sure to stop the ascent of the females, while wooden troughs of oil built around the bottom of the trunk is almost equally efficacious. Care and attention, and, above all, co-operation among those suffering from these worms, would enable us to check their ravages.—*Scientific Farmer.*

CURIOUS AUSTRALIAN IMPLEMENT.

MR. J. P. GLOVER, in *Nature*, figures the following instrument used by the Australian "river" blacks to throw their light reed spears with, which consist of a heavy miall-wood point and a shaft of reed. The bone hook is inserted in the head of the reed, the spear resting between the forefinger and thumb of the hand that holds the thrower and lying parallel to it, thus:

the spear being propelled from the hooked end of the thrower, which is rapidly brought forward into a vertical position, thus propelling the spear before it.

GLANDS OF THE DIGESTIVE APPARATUS OF INSECTS.

By M. JOUSSET.

THE physiological functions of the glands of the digestive apparatus of insects have not yet been determined with sufficient certainty; hence the differences of opinion that exist in science as to the part to be attributed to each of these glands in the digestion of food.

The naturalists who have paid attention to this subject have almost always made use in their researches of the liquid contents of the digestive tube; and I have thought that the different results at which they have arrived were to be ascribed to this very defective practice, since these liquids are complex and mixed in always unknown proportions. I have therefore sought amongst the various insects for one in which the arrangement of the glandular organs might enable me to collect these liquids in the gland itself, before their entrance into the digestive tube.

The cockroach (*Blatta orientalis*) is in this case. The three glandular groups of its digestive apparatus are very favorable to experiment, and arranged as follows: the upper region, consisting of an œsophagus, a crop, and a triturator apparatus, bears œsophageal glands in bunches, called *salivary glands*, nearly 1 centim. in length; the middle region or stomach presents eight glandular cæca, 4 or 5 millims. in length; and, lastly, the lower region, or intestine, bears Malpighian tubes which are easily isolated. These three glandular apparatus occur in all insects; but they vary much in dimensions, and are usually too small to enable us to collect the contents in a state of purity. The cockroach thus forms a fortunate exception.

By experimenting with these liquids collected before their entrance into the digestive tube, I have been able to ascertain that the sole agent in the digestion of amylaceous matters is the secretion-product of the œsophageal or salivary glands. I have convinced myself, by direct experiment, that none of the other glands possesses a marked action upon amylaceous substances, and that the secretion-product of the salivary glands has no action upon the albuminoid and fatty foods. I think that the digestion of feculent substances takes place principally in the crop in those insects which have the œsophageal glands greatly developed, like the cockroach—and that when these glands are small and lodged in the walls of the œsophagus, this digestion, which in this case is of little importance, takes place in the stomach. The glucose produced is absorbed by the stomach and does not pass into the intestine.

The cæca which surround the stomach are endowed with quite different properties. They secrete a yellowish liquid, which is feebly but distinctly acid. After collecting a sufficient quantity, I ascertained that, as already stated, it has no action upon amylaceous matters, but that it dissolves with remarkable energy the albuminoid substances, coagulated albumen, caseine, and in particular fibrine, of which it rapidly liquefies as much as twice its own volume. I have also ascertained that the albuminoids were not simply dissolved, but transformed into true peptones, no longer coagulable by heat or by acids, but only by bichloride of mercury.

The liquid of the cæca further possesses the property of energetically emulsionizing fats, a property which is not shared either by the salivary glands or by the Malpighian tubes. This emulsion lasts for a very long time and acquires a marked acidity.

We see, therefore, that in a general way the product of the gastric cæca constitutes the most important agent of digestion in insects; and those of them which, like the herbivorous insects, feed upon substances difficult of digestion, possess innumerable gastric cæca and have at their service a great quantity of this liquid. This property of emulsionizing and acidifying fatty matters, which the gastric juice of the Vertebrata does not possess, appears to approximate this product of secretion to the pancreatic juice; and the assimilation would be complete if it applied also to the amylaceous substances; but we have seen that this function belongs exclusively to the œsophageal glands in the digestion of insects. Nevertheless, taking into consideration the weak acidity of the liquid of the cæca and its action upon fats, I incline to regard it as presenting much analogy with the pancreatic juice, the character of the action upon starches not being primordial in the pancreas, as M. Claude Bernard has demonstrated that in certain fishes this organ is already destitute of action upon amylaceous matters.

However this may be, I believe that the peptones formed in the stomach and the fatty emulsions are absorbed at once by the walls of the stomach, which is the essential part of the digestive apparatus and plays the double part of the stomach and the small intestines of the Vertebrata. The materials which have resisted these actions, and which are consequently unfit for digestion, alone pass into the intestine, which I regard as playing scarcely any part in digestion properly so called.

The Malpighian tubes in these researches have always offered clearly negative characters. Their product of secretion does not act upon amylaceous substances, or upon albuminoids, or upon fatty matters. This confirms the opinion generally adopted that this group of glands is purely and simply an organ of excretion, a urinary organ probably more complete than that of the Vertebrata, since it is the sole eliminating organ of insects. The presence here of uric acid and of urates has long since been ascertained; but perhaps they furnish other principles analogous to the excrementitial matters that the liver has to eliminate in the Vertebrata.

These researches confirm the opinion long ago maintained by M. Blanchard as to the very high grade that insects should occupy in the animal series. We see, in fact, that their digestive functions greatly approximate to those of the higher Vertebrata.—*Comptes Rendus.*

BEDS of ore yielding 30 per cent pure nickel have recently been found near Onailon, New-Caledonia.